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NEOTROPICAL MIGRATORY BIRDS AND LIVESTOCK GRAZING

A Literature Review

Prepared by: Susan Yasuda
Wildlife Biologist

Prepared by: Matthew Johnson
Wildlife Biologist

Prepared by: Elaine Chasse-Demers
WildlifeBiologist/Range Conservationist

U.S.D.A. Forest Service
Eldorado National Forest
Placerville Ranger District

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INTRODUCTION

Management for livestock production occurs on approximately 86 million hectacres of federal land in 17 states (Bock et al. 1994). The United States Department of Agriculture (USDA), Forest Service manages over twenty percent of the land base in California (Sharpley-Evans in NTMB Reference Handbook 1994). Cattle are the primary livestock grazed on forests in California. Sheep grazing continues on public land but only on a few allotments on national forests (Peterjohn and Sauer 1992 in NTMB Reference Handbook 1994).

Approximately 125 different neotropical migratory bird (NTMB) species occur on the national forests in California, during some part of their life (Sharpley-Evans in NTMB Reference Handbook 1994). Migratory birds that winter in the tropics and nest on the continental United States are showing declines in populations based on the breeding bird surveys conducted by the U.S. Fish and Wildlife Service (Peterjohn and Sauer, 1992 in NTMB Reference Handbook 1994).

The purpose of this paper is to provide a literature review of effects of grazing on riparian, grassland, oak woodland and coniferous forest habitat and associated neotropical migratory avifauna on Forest Service lands in California. Species specific responses and impacts to neotropical birds utilizing the habitats addressed in this document are based on empirical information from studies on specific species or groups of birds. Where specific information is lacking on specific species, predictive assessments are derived based on known effects of livestock on habitat elements.

To understand the impacts of grazing on neotropical birds, managers need to know the effects of grazing on all aspects of the habitat and not just impacts to vegetation alone. To leave out analysis of habitat elements such as soil, watertable and quality, and prey base may lead to erroneous conclusions. This paper strives to incorporate the effects of grazing on all components of the habitat so that direct and indirect effects to neotropical migratory birds can be assessed and managed accordingly.

The paper is set up in the format of an introduction, affected habitat types (riparian, oak woodland, grassland and coniferous forest) and their corresponding avifauna, effects to habitat types, effects to avifauna, recommendations, conclusion, and bibliography.

A determination section was not included as individual land managers will need to assess the condition of their rangeland and status of neotropical birds on their own forests to come to those decisions over future management options for individual species. To provide assistance in determining which species may occur on individual forests and more

detailed information on each neotropical migratory bird species in California, one can refer to the Neotropical Migratory Bird Reference Handbook that Region 5 of the U.S.D.A. Forest Service produced in 1994.

HABITAT

In order for land managers to effectively predict the impacts of various management activities on bird species, they must first have a thorough understanding of how birds use different habitat components, and how those components are affected by different kinds of practices (Bull and Skovlin 1982). Although the sampling of bird communities is useful, important features of the habitat must also be understood, and research which identifies habitat features that are good predictors of bird species presence should be stressed (Verner 1981). Bird species distributions are most often determined by the habitat type and associated vegetative characteristics, primarily density and structure (Douglas et al. 1992, Szaro 1980).

Structure in vegetation can be expressed in a variety of forms, including the number of vegetative layers, patchiness, interspersion of successional stages, edge, and snags (Bull and Skovlin 1982). The diversity of bird life that a vegetative type can support has been directly linked to the degree of vegetative layering (Hurst et al. 1980). As the structure of the vegetation becomes more complex opportunities for nest sites and food resources increase, allowing additional birds to inhabit the area (Bull and Skovlin 1982). It has been suggested that vegetative structure provides proximal factors for habitat selection, which in turn lead to ultimate factors such as food, nest sites, and protection from predators (Douglas et al. 1992).

Birds are particulary responsive to changes in the physical structure of habitats in which they nest and forage (Bock et al. 1994). Williams and Lillybridge (1983) point out two important areas where knowledge of plant associations is most useful: 1) in planning management strategies and predicting the response to disturbance, and 2) by providing a common framework for describing forest stands so that management successes and failures can be communicated. The presence or absence of a particular vegetation strata can be important in determining the specific bird species composition (Stauffer and Best 1980).

Management activities which increase the structural diversity of habitat would tend to benefit the most species and therefore increase the diversity of bird species (Bull and Skovlin 1982, Stauffer and Best 1980). It is important to note however, that the goal of managing for maximum avian diversity could be detrimental to rare or sensitive species which have special habitat requirements but contribute little to overall diversity (Stauffer and Best 1980). Although species may sometimes be conveniently grouped into functional ecological guilds based on shared ecological similarities (nesting location, foraging mode, etc.), they must not be viewed simply as interchangeable parts.
Each species requires individual assessment for its response to management activities in

forest ecosystems, and geographic variation in these responses among populations within species occur and should be expected as the norm (Dopkin 1994). A thorough understanding of wildlife needs and limiting factors is important for developing appropriate management programs (Kie and Loft 1990). By understanding the association between birds and habitat, management activities can be implemented to provide habitat for a particular species or a group of species (Bull and Skovlin 1982). For species exhibiting a decline, the Forest Service can play a major role through changes in management practices pertaining to grazing on public lands. Neotropical birds provided with intact habitat stand a better chance of recovery enabling population declines to be reversed.

RIPARIAN

I. HABITAT TYPE DESCRIPTION

Riparian habitats throughout California are quite variable and structurally diverse (Mayer and Laudenslayer 1988). For the purpose of this analysis, riparian habitats will include the montane riparian, valley foothill riparian, desert riparian, and wet meadow habitat types identified in the California Wildlife Habitats Relationship (WHR) guide to wildlife habitats (Mayer and Laudenslayer 1988).

The montane riparian habitat type usually occurs as narrow, often dense groves of deciduous trees with a sparse understory. At the higher elevations the overstory canopy is less varied in height with shrubs predominant, or only the shrub stage occurs. This vegetation type is associated with intermittent and perennial stream courses between 3,000 and 8,000 feet in the Klamath, Coast and Cascade Range, the Sierra Nevada, northern Santa Barbara County, and the Peninsular and transverse ranges of southern California (Grenfell 1988a).

The valley foothill riparian habitat type occurs in areas where deep alluvial soils and high water tables exist, bordered by sloping alluvial fans, slightly dissected terraces, lower foothills and coastal plains. This habitat ranges in elevation from sea level to 3,000 feet (Grenfell 1988b).

Desert riparian habitats are found along perennial streams, seeps, and springs in the Mojave and Sonoran deserts, generally at elevations less than 3,000 feet. The vegetation here varies from dense groves of low trees or shrubs to woodlands consisting of small to medium sized trees (Laudenslayer 1988).

The wet meadow habitat type occurs at all elevations in virtually every forest type, as well as inclusions in coastal prairies and the sagebrush steppe. These meadows generally

have simple structures dominated by herbaceous species with shrub or tree layers being absent or sparse (Ratliff 1988).

Aspen occurs in many types of western forests but only rarely occurs in extensive stands outside of riparian habitats, except in Colorado and Utah (Dopkin 1994). For the purpose of this paper, aspen is included in the riparian habitats mentioned above, when aspen is a natural component.

II. AVIFAUNA USE

More than any other western habitat, riparian woodlands are centers of high diversity and abundance of neotropical migratory birds (Bock et al. 1994). Less than 1% of the western United States contains riparian vegetation, yet more species of birds use them for breeding than any other habitat type in North America (Douglas et al. 1992). Neotropical migrants usually comprise the majority of species in these riparian communities.

A. Breeding

The presence or absence of many neotropical migrant species in riparian habitats is intimately tied to the complexity and density of vegetation structure, especially in the shrub and herbaceous layers (Dopkin 1994). At least twice as many birds may be found breeding in riparian areas than adjacent non-riparian areas (Stevens et al. 1977), and many species of birds breed exclusively in riparian areas and are not found at all in adjacent habitats (Hurst et al. 1980). According to Gaines (1977) riparian forest birds can be grouped into four guilds based on their usual choice of nesting site: 1) birds that nest on the ground, 2) birds that nest in shrubs, 3) birds that nest amongst foliage or branches of trees, and 4) cavity nesters.

In order for birds to reproduce successfully, not only must suitable nesting sites be available, but there must be an adequate food supply for themselves and their young (Gaines 1977). Because young birds are fed a high protein diet, regardless of the parent's food preference, food supply has been said to govern the choice of breeding sites (Lack 1968 and Orians 1971). Because of the large amount of foraging area in the foliage, trunk, and branch networks of cottonwood-willow forests, bird territories are generally small (Gaines 1977). Although few bird species breed in montane meadows, they provide important foraging habitats for species of adjoining bird communities (Samson 1988).

Foliage, bark and the ground all provide important foraging substrates for nesting riparian forest birds. Insects are the primary food source for most species, although seeds also are important, especially for ground foraging birds. Seasonal foliage and insect abundance permit a large number of migratory birds to breed in cottonwood-willow riparian forest habitat (Gaines 1977).

B. Migration

Bird community composition and density is known to fluctuate yearly and seasonally in a variety of habitat types. Each season, as winter and summer residents come and go the composition of the bird community changes. Variation during the spring and fall occurs because of the high value of riparian areas as migratory corridors (Szaro 1980). Heterogeneous deciduous vegetation offers a variety of habitat niches for migrants and attracts a greater number and variety of bird species during migration than during the breeding season (Knopf, et. al 1988, Stevens et al. 1977).

In summer, riparian forests provide the only lush, insect rich forest habitat in lowland, cismontane California. The importance of these forests to southward (fall) migrants cannot be underestimated. In Gaines' (1977) study, of 182 southward migrants, 65% were hatching year (immature) birds. Subcutaneous fat indicated that migratory birds lay-over several days in riparian forests habitat while they forage and store the fat needed to fuel their migratory journeys.

C. Wintering

Winter bird diversity is high in some riparian habitats, such as valley riparian (Gaines 1977), and low in others such as wet meadows and high mountain streams (Winternitz 1976). Gaines (1977) noted that the high percentage of migratory birds that occur in cottonwood forests in the Central Valley suggests that those riparian forests are important wintering habitats for many species that breed in the montane and northern coniferous forests. The availability of wintering habitat may be an important factor limiting the populations of some of those species. In addition, some "irruptive" species of mountain birds, such as band-tailed pigeon, varied thrush, and golden crowned kinglet, may move into lowland riparian forests from their usual montane winter habitats, possibly as a result of food shortages (Gaines 1977). Hurst et al. (1980) found many species which are primary winter residents such as the Savannah sparrow, and many summer residents, such as the barn swallow utilize the same area simultaneously in the spring and fall.
Gaines (1977) found that with the change in seasons the foliage gleaning insectivores of the breeding avifauna are replaced by the ground foraging granivores of the wintering avifauna. Although granivore species are usually associated more with upland or altered

sites, they do use riparian habitats heavily in the winter for foraging (Knopf et al. 1988), depending on shrubs and brambles for escape and thermal cover (Gaines 1977).

Because of the lack of foliage, arboreal birds subsist primarily on quiescent insect life (eggs and pupae), seeds (grass and forbs), and fruit (acorns, poison oak and mistletoe berries) (Gaines 1977).

III. DIRECT EFFECTS TO HABITAT

Riparian areas provide important habitat for wildlife and fish species, while supplying forage for domestic livestock (Schulz and Leininger 1990). Given the opportunity, most livestock, especially cattle, will spend a disproportionate amount of time in riparian areas (from 5 to 30 times longer) as compared to adjacent xeric upland areas (Clary and Medin 1990). Both domestic and wild ungulates prefer this habitat type because it contains easily accessible water, more favorable terrain, hiding cover, soft soil, a more favorable microclimate and an abundant supply of palatable forage (Behnke and Raleigh 1979; Krueger 1983; Platts and Nelson 1989; Skovlin 1984).

Platts (1984) found that 85 percent of the studies he reviewed concluded that livestock grazing degraded stream-riparian habitats. However, riparian areas have the ability to recover quickly, and provide managers with the opportunity to regenerate a degraded habitat. Range and wildlife managers need to know how vegetation change progresses in riparian areas and the impacts caused by livestock grazing (Schulz and Leininger 1990). Through responsible and ecologically sound management practices that attempt to control livestock distributions, proper sustainable grazing of streamside vegetation is possible (Platts and Nelson 1985).

A. Soil Impacts

Grazing impacts to riparian soils result primarily from erosion and sedimentation due to the direct loss of vegetation and ground disturbance, from compaction by trampling, and from alteration of plant species composition from a tree dominant habitat to a shrub or forb vegetation type (Platts 1979, 1985).

1. Erosion

In riparian habitats, shrubs, trees, and the tough sods produced by plants that thrive in high water tables are major contributors to the streambank stabilization. Improper livestock management in riparian areas which results in the loss of riparian vegetation

and/or a reduction in plant vigor can increase the amount and rate of erosion (Knopf and Cannon 1982; Kauffman and Kreuger 1984, Skovlin 1984). Erosion related to livestock grazing can result in significant annual streambank vegetation losses in herbaceous, shrub, and tree dominated habitats (Kauffman et al. 1983). Riparian species such as willow, alder, aspen, and sedges provide the root network for soil retention while above ground stems and foliage bend during high flows and dissipate flood energy, thus protecting floodplains from scour erosion (Crouch 1986; Crouch and Honeyman 1986; Elmore and Beschta 1987; Platts et al. 1987; Skinner et al. 1986, Swanson 1989). Some sedge dominated riparian communities in Nebraska average more than 100 feet of roots and rhizomes per cubic inch of soil near the ground surface (2m/cm3) (Swanson 1989). Grazing intensity, stocking levels and season of use influence the erosive potential of a riparian site, as well as geomorphological factors such as soil type and structure.

In areas with deep alluvial soils, the loss of upland vegetation and topsoil can cause accelerated downcutting of the stream channel (Chaney et al. 1990) Downcutting lowers the streambed and the groundwater table, reduces the riparian area, and destabilizes streambanks (Chaney et al. 1990). Buckhouse et al. (1981) concluded that most erosion takes place during the non-grazed, overwinter period and that significant patterns of accelerated streambank deterioration related to moderate livestock grazing could not be found. However, Kauffman et al. (1983) suggested that streambanks weakened by trampling and forage removal may be more susceptible to damaging effects by ice flows and high water than ungrazed streambanks, and that late season grazing caused significantly greater streambank disturbances (undercut collapse, cave-ins and bank sloughoffs).

Kauffman et al. (1983), found that streambanks with herbaceous cover had mean annual soil loss of 14 centimeters while shrub dominated and tree covered banks had soil erosion losses of 28 centimeters and 26 centimeters respectively due to late season grazing. These results led the researchers to conclude that each riparian site has individual attributes as to soil retention capability, and management applications should be site specific.

2. Compaction

Soil compaction from livestock trampling in riparian habitats can be mainly attributed to high concentrations and prolonged congregations of livestock seeking the shade and lush vegetation typically associated with riparian zones (Platts 1979, 1985). In addition, cattle generally prefer slopes of less than 35 percent, which may also contribute to their high concentrations in certain riparian lowlands (Bryant 1982). The intensity of trampling (number footfalls/area) has been shown to have a greater influence on vegetation survival

than the timing of tramplings (Abdel-Magid, et. al 1987). Hoof action can account for as much as 15-25 percent of the plant material removed during grazing, potentially creating substantial impacts to vegetation (Abdel-Magid, et. al 1987). Impacted soils in grazed areas often result in reduced plant growth and greater surface water flow, thereby creating a drier site and increased erosion potential (Clary and Medin 1990).

3. Runoff and Sedimentation

The likelihood of livestock grazing increasing the amount of sediment deposition in streams depends on such factors as landform, grazing strategy, climate, condition of the vegetation and grazing intensity (Platts 1979, 1985). Stream channel sedimentation is a direct result of the elimination or reduction of riparian vegetation due to extreme overuse by livestock (Armour et al. 1991). Platts and Raleigh (1984) suggested that avoidance of detrimental impacts may best be achieved through the maintenance of natural streambanks and the associated vegetation. Lusby (1970) also concluded that ungrazed watersheds in his Colorado study area contributed only 71 to 76 percent as much sediment as did the grazed watersheds (Lusby 1970 in Platts 1982).

In addition to binding erosive soils, riparian vegetation provides roughness at the water-land interface which can decrease water velocity and available energy for sediment transport (Swanson 1989). Winegar (1977), comparing sediment loads in a protected and unprotected channel, found that two important riparian plant functions were channel stabilization and influence on soil deposition. He also noted a less understood function of plant roots: the filtration of soil particles from flowing water. While water samples from the unprotected stream remained turbid for several days after sampling, water taken from the outflow of the ungrazed, protected area cleared within 3 hours. Winegar interpreted this as a capacity of the riparian vegetation in 3.5 miles of vegetated channel to retain extremely fine soil particles not otherwise arrested. Similarly, Platts et al. (1987) found that willows filter overland water flow, trapping sediments from upstream erosion and surface flow from adjacent uplands. The large deposits of fine, fertile soils on many flood plains can be attributed to the various filtering effects of riparian vegetation (Swanson 1989).

B. Water Impacts

Kovalchik and Elmore (1992) compiled a list of some of the potential hydrologic changes resulting from grazing and altered community composition: soil compaction, lower soil infiltration rates, increased surface erosion, accelerated loss of streamside and instream cover with increasing bank and streambed erosion; increased stream channel capacity with less dissipation of flood energy over the floodplain; straightening of the stream

channel resulting in higher water velocity, especially at headcuts and cut meanders; increased peak flow and lower summer flow; increased flood energy causing either downcutting or braiding (if bedrock is near the surface); lowered floodplain water tables; and reduced availability of soil moisture and increased water temperature.

Livestock grazing has the potential to cause a number of undesired modifications to riparian streamcourses and streambanks. Miner et al. (1992) identified two motivating factors for livestock use of watercourses: time spent drinking in the streambed, and time spent grazing and resting in the lush riparian area. Pinchak et al. (1991) found that cattle expressed a preference for areas within 366 meters of water and tended to avoid areas beyond that. The selection of upland sites by cattle is affected by the presence or absence of available water in upland reservoirs (Smith et al. 1993). Other studies support the conclusion that water is the major factor affecting cattle utilization patterns (Bryant 1982, Gillen et al. 1984, Roath and Krueger 1982).

Livestock grazing can change channel morphology via sediment accrual, alter channel substrate composition, disrupted pool-riffle relationships, channel widening, and increased runoff (Minshall et al. 1989, Platts 1986). In a comparison of heavily grazed sites and lightly grazed sites along a stream, Platts (1981) found that stream widths were over four times as wide with over four times as much water surface area exposed to solar radiation in the heavily grazed study site because of streambank erosion caused by heavy livestock use. In addition, stream depth at the streambank-stream surface interface was almost 13 times greater at the heavily grazed site than at the lightly grazed site. Duff (1977) also reported a marked widening (173%) in stream channels of a heavily grazed stream segment in Big Creek, Utah. Overgrazing has long been assumed to be the cause of channel alteration in ephemeral streams, which cover more area and have less vegetative cover potential than perennial channels (Smith et al 1993). Hayes (1978), suggested that ungrazed or unburned meadows may in fact suffer from a lack of vegetative vigor, and thus be susceptible to undercutting. He reported that rest-rotation grazing in meadows did not significantly alter channel movement. However, in wet meadows, cattle grazing can slow or reverse plant succession (Kie and Loft, 1990).

The amount of runoff entering a stream channel is often accelerated by the effects of overgrazing. Runoff normally increases with an increase in grazing pressure, and can be as much as ten times greater in areas that were heavily grazed versus those receiving light grazing (Sharp et al. 1964). Rauzi and Hansen (1966) found that water intake rates on differentially grazed watersheds were nearly linear, with the heavily grazed watershed having the lowest and the lightly grazed watershed the highest rate. Overgrazing of uplands that supply riparian systems can modify runoff patterns and significantly reduce stream volumes or groundwater supplies (Johnson et al. 1987).

Storm characteristics are also an important factor in the production of runoff. Unusually abundant rainfall over an extended period of time can result in higher runoff rates in lightly grazed areas than in heavily grazed area (Sharp et al. 1964). Rauzi and Hanson (1966) suggested that closely managed grazing can decrease runoff and increase the amount of available precipitation entering the soil for plant use.

The removal or reduction of riparian vegetation in many cases leads to the removal of the riparian canopy resulting in a loss of stream shading. This can lead to increased penetrations of sunlight and an increase in water temperatures (Behnke and Raleigh 1979, Platts 1981). The opportunity for natural dominants (such as willows) to maintain their previous hydrologic condition could be lost, and recovery may take years, decades, or even centuries depending on the size and nature of the system and the interim management (Swanson 1989; Van Haveren and Jackson 1986).

Finally, grazing can result in a lowered floodplain water table and reduced availability of soil moisture (Kovalchik and Elmore 1992). Swanson (1989) notes that a higher water table will supply the necessary water to riparian vegetation, yielding the benefits of bank stability and consequently maintaining the high water table situation along the streamcourse. Even riparian vegetation on degraded streambanks can rapidly respond when a high water table becomes accessible (Swanson 1989).

C. Foliage Impacts

Given the fact that cattle will spend a disproportionate amount of time in riparian areas (Clary and Webster 1989, Roath and Kreuger 1982), vegetation within the riparian zone is often subjected to heavy grazing pressure and prolonged exposure to livestock. Consequently, many researchers have documented the various effects to the vegetative strata of riparian habitats -herbaceous and grass, shrub, and upper canopy layers (Roath and Kreuger 1982, Medin and Clary 1989, Clary and Webster 1989, Schulz and Leininger 1990, Kovalchik and Elmore 1992).

Forage is the vegetation available for consumption by herbivores (Fletcher 1992). Graminoids and forbs are often grazed first by livestock and are utilized heavily because of their relative palatability, especially in the early season before they mature and dry (Roath and Krueger 1982). Medin and Clary (1991) found that only the herbaceous vegetation layer was reduced (50% of total biomass and height values) with light to moderate grazing intensities (2,495 AUM/11,555 acres, mid-July through mid-November) along a northeast Nevada stream. In another study, no significant difference in characteristics of small shrubs or sagebrush were detected from grazing, but vegetative grass heights and standing crop biomass differed significantly between grazed and ungrazed plots (Clary and Medin 1990). Kauffman et al. (1983) also detected the heaviest

utilization in a northeast Oregon stream on streambanks that were dominated by grass and/or herbaceous species (mean of 59 percent) versus streambanks dominated by shrubs and trees (mean of 22 percent). Utilization was the lowest in exclosures (always less than 20 percent) where big game accounted for the use. This preference generally leads to a lowered total forb biomass on grazed sites (Kovalchik and Elmore 1992). Under more intense grazing pressure (600 AUM out of 621 AUM carrying capacity, from mid-June through mid-October), grazed areas may contain up to 5 times as much bare ground as sites excluded from cattle (Schulz and Leininger 1990).

The species composition of forb communities may be altered by moderate to heavy grazing intensities. Sharp et al. (1964) found that total amount of vegetation under light grazing was twice that found under heavy grazing conditions, and the lightly grazed watershed had an abundance of high producing midgrasses whereas the heavily grazed watershed consisted mostly of shortgrasses. In north central Colorado, Kentucky bluegrass, a non-native species that is considered an indicator of overgrazing in wet meadows, was 4 times more abundant on grazed areas while fowl bluegrass, a non-native species which is adapted to wet habitat types, was 6 times more abundant on the protected sites (Schulz and Leininger 1990). These results indicate a transition in vegetation type from wet to dry meadow induced by heavy grazing. Kauffman et al. (1983) stated that exotic grasses which flourish in drier environments will often be replaced by native sedges and forbs better adapted to wetter environments.

High levels of livestock use are mediated to some extent by the resilience of many herbaceous species. In their review of management practices in the Intermountain region, Clary and Webster (1989) point out that permanent removal of grazing will not always guarantee maximum herbaceous plant production. Many grass species are highly tolerant to defoliation under low grazing intensities, and shoot frequency, density, vigor, and cover may not be effected (Schulz and Leininger 1990). Some species are adapted to grow most rapidly in response to light grazing, and the accumulation of litter on ungrazed sites may retard herbage production. Litter cover has been found to be twice as high in exclosures as in grazed areas (Schulz and Leininger 1990).

The woody structural component of riparian vegetation is essential for wildlife species that are obligate inhabitants of willow thickets, such as Wilson's warbler (Tucker 1987, Finch 1987), and in providing hiding cover and stabilizing streambanks for fish habitat (Marcuson 1977, Stuber 1985). The shrub layer lacks the resistence to defoliation found in the forb layer, which contributes to the heavy impacts often associated with this vegetative strata of montane riparian habitats. Shrub volume, height and density have been shown to be inversely proportional to grazing frequency and intensity (Taylor 1986, Clary and Webster 1989). Schulz and Leninger (1990) found that total shrub cover in protected exclosures

was 5 1/2 times higher than in grazed areas, yet total forb cover was similar in both areas. Marcusen (1977) found shrub production in Montana to be 13 times greater in control areas when compared with riparian sites grazed by cattle.

Willow dominated shrub associations in good condition can produce large amounts of forage (from 2,000 to 5,000 dry pounds per acre, estimated) (Smith 1983). Livestock grazing often does not maintain these communities. Improper use by livestock, sometimes in conjunction with poorly managed big-game herds, has degraded the majority of willow dominated sites, decreasing forage production and reducing or entirely eliminating willows from many suitable habitats (Kindschy 1985; Kovalchik 1987; Munther 1981; Swenson and Mullins 1985). In fact, willow canopy coverage can be up to 8 1/2 times greater on areas that are protected from season-long grazing (Schulz and Leininger 1990). Skovlin (1984) suggested that the intensity of grazing may be more important to riparian vegetation maintenance than season of use. Kovalchick (1987) speculated that continued excessive grazing may eliminate a willow stand within 30 years, depleting the protective function of the shrubs in riparian zones. Although woody plant species can increase rapidly when riparian areas are protected from livestock grazing (Rickard and Cushing 1982, Swanson 1989, Winegar 1977), Knopf and Cannon (1982) estimated that it may take more than 12 years of livestock exclusion on some sites for a riparian willow community to recover.

In general, preference for willows is greater in cattle than in sheep, however, cattle tend to be more destructive than sheep when they congregate in riparian zones (Smith 1982). Damage to willow stands occurs when livestock browse and physically break lower branches as they seek summer shade or more palatable forage (Knopf and Cannon 1982). Although willow utilization can occur early in the year if range allotments are overstocked, utilization usually remains low as long as other palatable herbaceous forage is available (Kauffman et al. 1983). Most browsing pressure and damage occurs in the late summer as the more palatable forage resources are depleted or as alternate forage resources decrease (Kauffman et al. 1983, Smith 1982). Kovalchik and Elmore (1992) reported that cattle in central Oregon began using the current annual growth on willows when riparian forage use reached about 45 percent of total available forage, then increased usage again at 65 percent. Cattle ate all the willows available to them at 85 percent range utilization, and utilized willow the heaviest when riparian herbaceous forage use reached about 4 to 6 inches stubble height.

When cattle shift their diets from grazing to browsing, immediate impacts to the lower strata can occur, even through short-term exposure (Taylor and Littlefield 1987). Knopf and Cannon (1982) concluded that cattle alter the structure of willow communities by changing the size, shape, volume, and quantity of live and dead stems per bush, and the spacing of plants. First year willows are especially susceptible browsing of young shoots

often kills the entire plant because they are easily uprooted or killed by trampling. This can result in poor recruitment of young trees and may lead to a community comprised predominantly of mature willows. Eventually, in the absence of recruitment, the old willows die and willow stands are eliminated (Conroy and Svejcar 1991). Kovalchik and Elmore (1991) noted that many older willow stands have reached this point, with little natural regeneration occurring on poorly managed range allotments.

An indirect cause of willow decline is the alteration of the water table by grazing. The replacement of willow and alder with currant can occur when water tables are lowered in response to grazing or other stresses on the stream channel. Restoration of the water table to prior levels may allow the willow and alder to regain dominance (Clary and Medin 1990).

One of most profound impacts of livestock grazing in dense willow shrub communities is a change in the physiognomic structure and density of willows within the community (Knopf and Cannon 1982, Krueger and Anderson 1985, Clary and Webster 1989). Taylor (1986) described how browsing of the lower branches by cattle created notched, or high lined willows that are top-heavy with live branches, but contain few live branches underneath. Kovalchik and Elmore (1992) described a "grazing line" on overgrazed willows where all young shoots had been grazed. The formation of tunnels can occur when cattle browse near the ground and break out lower branches as they advance through willow thickets, thereby exposing the interior portions of the shrub layer (Krueger and Anderson 1985). Knopf and Cannon (1982) found that tunnel floors were covered by a mat of grasses and/or sedges, and that in general, the width of a tunnel increased as the height of the tunnel increased. Kreuger and Anderson (1985) found that 41 percent of the shrubs that were sampled from two study sites formed tunnels. Under extreme grazing intensity, the structure can be altered completely, from a willow-dominated community to one that is characterized by defoliation-resistent Kentucky bluegrass (Schulz and Leininger 1990).

Schulz and Leininger (1990) noted that continued cattle grazing appears to limit the size of willows but not their densities. They noted that willows within exclosures were older and larger than those in grazed areas, which contributed to the average canopy cover in the exclosure by 8.5 times. Diameters of stems within the exclosure averaged 11 millimeter versus 7 millimeter in grazed areas. Smith (1989) found that willows were reduced 20 percent to 70 percent in height by severe cattle browsing within two years. Willows 1 to 2 meters in height suffered the most effect. He noted that although all willows taller than 3 meters showed some growth during the two year period, most had pronounced browse lines. Conroy and Svejcar (1991), studying the effects of grazing on planted willows, found that although willow cuttings were defoliated 3.5 to 5 times more in grazed pastures than

in ungrazed pastures, survival and leader length did not appear to be significantly affected.

Other important riparian shrub and tree species can be adversely effected by excessive grazing. Kovalchik (1987), studying alder/snowberry communities in central Oregon, found that alder communities decrease in vigor, lack young age classes, have patchy canopies, and experience highlining in response to overuse by livestock. Furthermore, the competitive ability of snowberry is reduced, making the community more susceptible to invasion by Kentucky bluegrass and forbs. He concluded that continued overgrazing can cause alder and snowberry to become uncommon. Smith (1989) found that young sycamores were absent and basal sprouts were rare or entirely absent along an intermittent stream in California that had experienced persistent, heavy browsing by cattle. He speculated that a regime of light cattle stocking might allow the sycamore population to maintain itself.

While livestock cannot browse directly on the upper canopy of riparian trees such as aspen or cottonwoods, they may have detrimental effects on the seedlings and saplings of overstory species. Cattle grazing in riparian zones over several decades can eliminate or reduce the upper canopy by preventing the establishment of saplings and seedlings (Glinski 1977). As a result, sites that are otherwise suitable for the existence of overstory tree species may be poorly stocked due to insufficient regeneration rates, resulting in a loss of tree regeneration and foliage height diversity (Kovalchik and Elmore 1992). Medin and Clary (1991) found little difference in aspen vegetation between grazed and ungrazed plots and found that the number of trees was similar on each plot over an 11 year period. However, they noted that a single stand of large aspen on the grazed plot tended to inflate average tree diameter and height values on the grazed plot. Cattle grazing reduced densities of cottonwoods in an Arizona stream, potentially reducing the width of the future riparian zone by as much as 50 percent (Sedgwick and Knopf 1987). Crouch (1978) reported a 50 percent loss of cottonwoods over an 18 year period of grazing in a northeastern Colorado bottomland. Sedgwick and Knopf (1991) noted that cottonwood floodplains are more resilient to grazing in the late autumn due to the major forage supplement provided by the falling leaves.

A. Impacts to Succession:

In wet meadows, cattle grazing can slow or reverse plant succession (Kie and Loft, 1990). In central Oregon, Winegar (1977) showed that grazing by domestic livestock was affecting the succession of a riparian corridor along Camp Creek. The continuously grazed site was stagnant in its successional progression, and was dominated by smoothbrome, poverty weed, and other forbs and graminoids. After only nine years of

livestock exclusion, the area rapidly transformed to a rich riparian habitat consisting of willow, cattail, rushes and grasses (Winegar 1977). Riparian areas can also be impacted successionally by livestock when browsing prevents the establishment of saplings that later mature into components of the overstory canopy (Glinski 1977).

Heavy sheep grazing in southern Sierra Nevada montane meadows increased runoff, erosion and stream entrenchment which lead to a lower water table, enabling establishment of lodgepole pine. Conifer invasions in subalpine meadows also occurred after periods of intense grazing (Bock et al. 1994).

B. Impacts to Reproduction:

As mentioned previously, first-year willow seedlings are very sensitive to grazing and are often killed by browsing and trampling. Poor willow reproduction can retard succession from immature to mature willow stands. Without recruitment, willow stands develop inbalanced age structures and can eventually die. Smith (1989) concluded that slow growth rates combined with infrequent germination of willows prevented them from establishing or surviving previous intensive cattle browsing, and that even light or seasonal cattle use might prevent the establishment of a significant willow population. First year survival rates for planted willow cuttings are good indicators of long-term survival. Conroy and Svejcar (1991) found that grazing in early or late summer did not significantly reduce first year willow survival. However, both stream channelization and water table level, which are both negatively affected by grazing, affected the survival rates of the cuttings.

IV. Indirect impacts

A. Water Quality

Miner et al.(1992) noted that as use of rangeland streams increases, the possibility of contracting a bacterial disease from water increases. Bacteria in fecal matter deposited on rangeland may remain viable for at least one grazing season. They found that over 99% of the time, the water quality of a stream in a rangeland pasture is dominated by the direct deposition of animal fecal matter, rather than fecal material which is "washed" into the stream during a runoff event, and that over 95% of these organisms settle to the bottom over a several week period and die entrapped in the sediment. They suggested that by minimizing time spent in the stream, the opportunity for direct fecal deposition into the water is correspondingly diminished.

B. Salt Licks

Driscoll (1967) indicates that too few salting sites may create concentrations of livestock large enough to damage the surrounding area. He suggests using several areas to encourage uniformity of forage use, which may eventually improve range conditions. However, Byrant (1982) indicated that placement of salt licks has little effect on altering livestock use patterns away from riparian areas nor did they encourage cattle to utilize more upland habitat.

C. Herbicides

The removal of willows either manually or through herbicides is used to increase the amount of forage available to livestock which in turn reduces the structurally diversity of riparian vegetation in the area (Taylor and Littlefield 1986).

D. Water Tanks

Water can be used effectively to control the distribution of livestock through the use of water developments in the form of water tanks, troughs or spring developments to encourage higher use of upland areas and decrease use in riparian zones (Driscoll 1967, Sherrets 1989, Yeo et al. 1993, Smith et al. 1993, Kochert 1989). However, open water storage tanks can entrap birds and will need to be modified with a floating platform to enable trapped species to escape (Sherrets 1989).

OAK WOODLAND

I. HABITAT TYPE DESCRIPTION

The oak woodland habitat type is widespread throughout Region 5, encompassing several different tree species and shrub/herbaceous associations. These include montane hardwood, blue oak woodland, valley oak woodland and coastal oak woodland (Mayer and Laudenslayer 1988). Blue-oak foothill pine and montane-hardwood conifer are mixes of both hardwoods and conifers and management concerns dealing with these habitat types and neotropical birds can be obtained from both the oakwoodland and coniferous forest sections of this document. Management practices currently applied to the oak woodland habitat type are generally not specific to a particular dominant tree species, so it is reasonable to group all oak woodland types, along with their management techniques and the impacts associated with them, into one conglomerate habitat - Oak Woodlands.

As defined within these parameters, the overstory of the oak woodland habitat type consists of sparse to moderate densities of deciduous or evergreen trees of blue, coastal live, interior live, valley, canyon, or black oaks. These oaks generally occur in a patchy distribution. The understory is typically represented by various types of chaparral, with

annual grasses and forbs being continuous between shrubs and under the oaks throughout the landscape (Mayer and Laudenslayer 1988). Oak woodlands grade into oak savanna, then semi-desert grassland, at the drier (and lower) end of type. Emory oak or Mexican blue oak (Quercus oblongifolia) typically are the dominant oaks in these savannas. At high elevations, oak woodland transitions into oak-pine woodlands, then pine or mixed-conifer forests (McPherson 1992).

Blue oak woodlands are often associated with California buckeye, interior live oak and coastal live oak in the overstory. Chaparral species are geographically distinct, and may include Ceanothus species, manzanita species, California coffeeberry, poison oak, Lupinus species, blue elder, California yerba-santa, and California redbud (Verner 1988).

Valley oak woodlands range from open park-like stands to thick forested woodlands comprised mostly of deciduous broad-leaved species, such as California sycamore, Hinds black walnut, interior live oak, boxelder and blue oak. Understory shrubs are various but include poison-oak, California wild grape, toyon, California coffeeberry and California wild grape (Ritter 1988).

Coastal oak forests are characteristically diverse, with the vegetative constituents being greatly influenced by moisture conditions, topographical location and elevational gradients. Overstory species include Oregon white oak mixed with other oak species and madrone in the north, coast live oak with madrone, California bay, tanbark oak, valley oak and silver pine in central California, and Engelmann oak in southern California. The shrub and herbaceous layers vary considerably as well, consisting of a wide range of species including California blackberry, toyon, brackenfern, manzanita species, chamise, Ceanothus species, coyote brush, bush monkeyflower, California sagebrush, and a number of grasses and forbs (Holland 1988).

Oak woodlands cover approximately 10 million acres in California (Ewing et al. 1988) and produce about a third of total rangeland forage supply (Huntsinger et al. 1991). The Spanish introduced livestock to the oak woodlands during the sixteenth century, and livestock production has remained an important use of the land since that time (Gottfried 1992). Evans (1988) reported that over 80% of the woodlands in the west are grazed by livestock, supporting between 1 and 1.5 million animal unit months of grazing/year.

II. AVIFAUNA USE

The oak woodlands are one of the most productive habitat types for bird species in North America (Verner 1983). Block et al. (1992) found 98 species of neotropical migratory birds

using various oak woodland habitat types in southeastern Arizona and California. Verner (1980) remarks on the difficulty of preparing a list of oak dependent bird species in California, due to the variety of growth forms taken by oaks, the widespread distribution of oak habitats in the state, and the frequent association of oak habitats with other types.

Balda (1969) noted heavy bird use in a pine-oak woodland in southeastern Arizona, and attributed this use to foliage height distribution. Mills et al. (1991) correlated breeding bird density with the total volume of vegetation in the habitat. Range differences of birds and the great diversity of vegetation types containing oaks act synergistically to provide suitable habitat for numerous breeding and migrating neotropical birds (Block et al. 1992). However, Block et al. (1992) found little similarity in the species or relative abundances of birds found in oak woodlands compared with those found in pine-oak woodland or mixed-conifer forests. This apparent difference suggests that oak woodlands provide resources for unique assemblages of birds.

As wildlife habitat, the woodlands are a mosaic of structural elements which reflects availability of critical habitat resources (Sharman and Ffolliott 1992). Verner (1980) lists a variety of uses by birds in oaks: foraging on acorns, catkins, sap, mistletoe berries, and gleaning insects from leaves, bark or wood; nesting in the canopy or in cavities; perching for rest and surveillance; and indirectly as a food source for prey species.

A. Breeding

Oaks are utilized by approximately 110 bird species during the breeding season (Verner 1980). Block et al. (1992) found that birds used oaks extensively for foraging. Oak acorns, leaves, twigs, wood, sap, and flowers are utilized directly or indirectly by many bird species. Acorns are consumed by at least 30 species of birds, including band-tailed pigeons and Lewis' woodpeckers. Several bird species, such as sapsuckers penetrate the bark layer of a tree to retrieve sap in the cambium. Flycatchers, vireos, and warblers are examples of long distance migrants that make use of the large insect population of oak woodlands. Ground foragers search for insects in the litter beneath the tree canopy and other species make use of the insects in oak galls (Pavlik et al. 1991).

At least 45 bird species obtain insects from oak foliage, twigs, bark or wood. Nine species catch aerial insects by launching from perches in oaks, at least three eat sap, and at least two consume significant quantities of berries from mistletoe growing on oak trees.

B. Migration

Bird usage of oak woodlands displays seasonality and an associated switch in foraging guilds (Block 1992). Many species are year-long residents, and others may use an area during nonbreeding periods as short-term migrants or as wintering birds. Birds such as the hermit and Townsend's warblers, use oaks as intermediate habitat during migration to and from their breeding grounds or during other parts of the year (Verner 1980).

C. Wintering

Wintering habitat is critical for a number of bird species. Some transient species are short-distance migrants that move downslope into oak communities during winter, such as thrushes, red-breasted sapsuckers, and ruby-crowned kinglets (Pavlik et al. 1991). Oak forests support 90% more wintering than nesting birds (Gaines 1977). Live oaks provide foliage for cover and are important for foraging for many species during the winter months (Verner 1980).

III. DIRECT EFFECTS TO HABITAT

The oak woodland habitats are affected directly by grazing livestock, and indirectly by management techniques aimed at improving or sustaining range conditions. Grazing has been blamed for reducing the number of viable acorns available to reseed the woodlands, for destroying seedlings and saplings, and for compacting soil, which further limits the chances of seedlings becoming established (Bolsinger 1988). Management techniques such as indiscriminate clearing of trees and woodlands in the hopes of stimulating forage production have also contributed to the deterioration or elimination of many acres of oak woodlands in California. These practices have been called into question after it was determined that they often times did not produce or sustain the desired forage increases, and were difficult to justify economically (Gottfried 1992).

Efforts to conserve and protect oak woodlands in California are often hampered by ownership patterns. According to Ewing (1990), eighty percent of the oak woodlands in California have been held in private ownership since the early 1800's. As a consequence, the long-term sustainability of the oak ecosystem depends on government, private landowners and others who may have a variety of ideas about the value and importance of oak trees (Ewing 1990). As development and population continue to increase in California, and during periods of economic downturn in the cattle industry, pressures to liquidate oak woodland resources for land development or for firewood will undoubtedly increase (Ewing 1990).

A. Soil Impacts

Livestock grazing can alter both the physical and chemical properties of oak woodland soils. In an artificial trampling experiment, Abdel-Magid et al. (1987) found that water infiltration rates decreased and soil bulk density slightly increased with the intensity of trampling on shortgrass prairie sods. Soil compaction and reduced soil water availability negatively influence the establishment and survival of oak seedlings (Gordon et al. 1990). In a parallel study, Abdel-Magid et al. (1987) found no increase in soil water infiltration from a short duration rotation grazing system that broke the soil surface with hoof action.

Ratliff et al. (1991) noted a more favorable production of forage beneath blue oak canopies than in the adjacent open areas with thin, cobbly soils. The soil profile within the influence of the oak canopy contained more humus, yielding an increase in water retention and nutrient levels (Ratliff et al. 1991). Hall et al. (1992) attributed winter trampling under blue oak canopies by livestock to the increased forage found in oak microhabitats, in conjunction with increased winter precipitation, which combined to yield soft, wet, easily compacted soils.

In research with blue oaks and forage production, Holland (1968, 1973) noted that greater herbaceous growth under blue oak canopies is associated with beneficial physical and soil properties associated with organic nutrient input, as well as the moderating influence on temperature attributed to canopy cover. The deposition and decomposition of litter (including the decay of roots) from blue oak canopies and herbaceous species gives the soil a higher humus content, resulting in a more distinct aggregate structure, a greater water holding capacity, greater friability, and lower bulk density (Holland 1969). This results in higher nitrogen, phosphorus, magnesium, calcium and potassium concentrations, having a higher cation exchange capacity and electrical conductivity in soils under oak canopies than in open grassland areas (Holland 1973). In a subsequent study, Holland (1980) noted that tree canopies moderate soil temperatures and reduce evaporation of soil water, which also contribute to the increased herbage production beneath canopies.

B. Water Impacts

The bulk of the research on impacts to water availability involves blue and valley oak species. Much of this work can be extrapolated to include other oak woodland species.

Rapid uptake of soil water by annual grasses negatively impacts the recruitment of blue oak seedlings by depleting water stores that would otherwise be available to oaks during the summer dry period. These results were attained in artificial trials with container plantings Gordon et al. (1989) and Welker and Menke (1992). Field trials conducted by Gordon et al. (1990) supported the experimental findings in that the availability of water

is crucial to the survival of blue oak seedlings. Both seedling emergence and continued growth showed an increase with the provision of late season water in grazed plots.

Adams et al. (1992) attributed the high emergence of blue oak in an above average rainfall year to an increase in available soil water and the pattern of seasonal rainfall. They noted an increase in emergence at 2 of 3 study sites during the wettest period, leading them to speculate that reduced recruitment of valley and blue oak seedlings can be expected in low precipitation years. Frost and McDougald (1989) found an increase in the early growth of herbaceous vegetation under tree canopies when rainfall was adequate, due primarily to warm temperatures and sufficient soil moisture. A significant finding of this study showed that during this initial period of growth, herbaceous forage levels nearly tripled under the tree canopies of blue and live oaks.

Close grazing methods are offered as a possible solution to late season soil water depletion by annuals. Hall et al. (1992) suggested that heavily grazed annual grasses will utilize less soil water than those that are grazed light to moderately, and that this technique might provide the edge required by blue oak seedlings to survive low water periods.

C. Foliage Impacts

Oak seedlings are susceptible to foliar damage from livestock grazing. Browsing may be incidental, where cattle ingest foliage while searching for more palatable forage. Conversely, cattle may graze preferentially on oak seedlings, leading to damaging and potentially fatal effects on the young trees from nipping apical buds, girdling, trampling and breakage of limbs and trunks (Hall et al. 1991). In a related study, Hall et al. (1991) found that cattle do feed on young oaks, and that the probability of damage to seedlings increases proportionally with the stocking rate. However, Welker and Menke (1992) found that trees severely damaged by grazing or trampling in January had a 95 percent recovery leaf out the following spring. They note that some researchers view defoliation as a beneficial effect when the plants are exposed to prolonged drought conditions, by the reduction of evapotranspiration from leaf surfaces.

Cattle are most likely to consume the leaves and stems of shrubs and small trees from November through January when green grass is scarce, but some amount of these plants can be found in cattle diets throughout the year. These woody species can provide protein and phosphorus that is missing from dry grass, but low digestibility can depress forage intake (Van Soest 1982). Browsing on oak appears to be insignificant, and the absence of a conspicuous browseline or highline on trees in the encinal oak woodland substantiates this point. However, according to microhistological analysis of fecal material, such oak species as Emory and silverleaf can comprise as much as 25 percent of cattle diets during

the winter (McClaren et al. 1992).

D. Canopy Impacts

Both the production and composition of herbaceous vegetation in oak woodlands is affected by the canopy coverage of oak species. Sampson et al. (1951) noted that undercanopy forage species consist mainly of low value herbs and grasses at peak standing drop. However, Bartolome and McClaren (1992) found few within year differences in forage species attributable to grazing between the open grassland and the oak understory. This study disputes previous findings that attribute variation in species composition between shaded and open areas based on forage content and grazing intensity.

The effects of the evergreen interior live oak canopy on herbaceous production is a result of the shading influence of year round canopy coverage. Frost and McDougald (1989) point out that shading can benefit understory vegetation during drought years by delaying soil water losses. Griggs (1986) also found that shade provided by oak canopies was a more important factor in attracting cattle than the species composition or nutrient content.

Extensive oak stands have been cleared with the purpose of improving forage production. Bolsinger (1988) summarized the conclusions of several studies and noted that the practice of clearing oaks does not always improve forage production or quality; but where stands are dense, especially on certain soils, the removal of oak trees can substantially increase the range value.

Kay (1986) measured the herbaceous forage response to killing or removal of blue oaks over a 21 year period (1965-1985) in the north-Sierra foothills of California. He found an increase in herbage production in all but three of the first 15 years, but production after the 15th year declined. Forage increases during the 15 year period averaged 66 percent if the roots were killed and 45 percent if only the tops were killed. The naturally occurring grasslands in the area averaged 26 percent higher forage production than the tree covered areas. The percentage of desirable forage grasses, total ground cover, nitrogen uptake/acre, phosphorus, sulfur, and the soil bulk density also increased following tree removal. In contrast, Holland's (1979) data clearly indicated that forage yields were significantly higher under both living and dead blue oaks when compared to open grasslands at the San Joaquin and Hastings Reserves. He found production was 60 percent higher under live blue oaks and 80 percent higher "under" dead trees when compared to open grasslands at Hastings. The results were similar at the San Joaquin reserve, where total forage production was 100 percent higher under live trees and 50 percent greater "under" dead trees.

E. Impacts to Reproduction and Succession

There is great concern regarding the future of native oaks in California. Recent studies have shown that blue oaks are not regenerating sufficiently to maintain stand densities (Mayer et al. 1986, Hall et al. 1991). A number of causes have been postulated for the lack of regeneration of California oaks, including grazing of seedlings by livestock (Burcham 1957), fire or fire suppression, competition of introduced plant and animal species (Griffin 1980), and predation of young trees by insects (White 1966, Knudsen 1987, Griffin 1971, 1976, 1980).

The diminished recruitment of several oak species may be associated with grazing by large herbivores, both domestic and wildlife species (Adams et al. 1992). A bottleneck in recruitment often occurs at the sapling stage because seedlings either do not establish or do not survive into the sapling class (Allen-Diaz and Bartolome 1992). There is no doubt that consumption of acorns by domestic livestock and many species of wildlife greatly reduces the number of acorns that might possibly become trees (Duncan and Clawson 1979). McClaran (1986) however, suggested that the transition from the seedling to sapling stage may be more critical in limiting recruitment than acorn germination or early seedling survival. Allen-Diaz and Bartolome (1992) also attributed the lack of oak establishment to factors controlling growth rather than to mortality during the seedling stage. They found that fire and sheep grazing regimes had no significant effect on the number of new seedlings, and that blue oak seedlings already present in the understory suffered a constant mortality rate over time while awaiting conditions for release into the sapling stage. They noted that removal of the canopy may be required for successful release of blue oak seedlings into the canopy, but that canopy removal does not ensure release.

White's data (1966) from Carmel Valley, California supports the hypothesis that neither grazing by domestic livestock or prescribed burns contribute to the lack of oak sapling establishment. He proposed that deer browsing may limit the growth of many oak seedlings, having found that only 12 percent of 154 seedlings located on the Hastings Reserve study site were unbrowsed by deer, and the others were reduced and bushy due to repeated grazing. Hall et al. (1991) however, suggests that at certain intensities livestock grazing may hinder regeneration. They found that under low stocking densities oak establishment was not affected, but under moderate or heavy grazing conditions, grazing of the apical buds and trampling may result in lowered oak regeneration. In a subsequent study, Hall et al. (1992) found that the season of grazing had a greater effect on seedling survival than stock densities. Seedling survival rates were increased when grazing occurred in the winter.

Adams et al. (1992) suggested that control of competing herbaceous vegetation appears to be essential in achieving adequate emergence and first-year survival of blue and valley oak seedlings developing from seeded acorns. However, competition for soil and water with non-native annuals did not appear to be a dominant factor in the studies conducted by Gordon and Rice (1993), although the growth of the seedlings was consistently higher in treatments containing no competing species. According to Rosiere (1987), the influence of grazing on understory vegetation in oak woodlands is minimal when compared to the natural factors of site potential and weather patterns (Rosiere 1987). Twisselman (1967) suggested that prolonged drought may have been the most significant factor over livestock browsing and competition with introduced annuals that effected oak reproduction in Kern County. Pase (1969) also cited drought as being the primary cause of emory oak and shrub live oak seedling mortality over a 3 year period in which half of the seedlings of each species died within the first year.

Ratliff et al. (1991) found that overstory trees had a moderating effect on the composition of understory species, favoring wild oats, soft chess and ripgut brome, all of which belong to later successional stages in the oak woodland habitat. They suggested that a diverse overstory, composed mainly of blue oaks, live oaks and foothill pines, may contribute to the diversity of the understory layer.

F. Indirect impacts

1. Fire

Oak woodland ranges are often intentionally burned to encourage forage growth and to reduce fuel volume. Under proper control and season (fall) these fires were shown to have no effect on oak establishment (Allen-Diaz and Bartolome 1992). Englemann oak studys on the Santa Rosa Plateau Preserve found that prescribed burns intended to enhance regeneration in oak woodland might be more effective if conducted in late summer or early fall to permit better survival of fresh resprouts, without first having to withstand the summer drought, as a spring burn would entail. (Lathrop and Osborne 1990).

Historically, fires probably occurred about every 10-20 years at the lower end of the oak woodland, adjacent to semi-desert grasslands (Wright and Bailey 1982). Fine fuel and above ground biomass was nearly always adequate in oak savannas to support fire spread (> 1000 kilograms/hectare of fine fuel is usually required to sustaining grassland fires) (Wright and Bailey 1982). Above ground biomass in emory oak savannas usually exceeds this threshold (Haworth 1992). An extended period of hot, dry weather occurred every year in these woodlands, and ignition sources (lightning, native Americans, early Anglos) were almost always available. Since barriers to fire spread between semi-desert

grasslands and oak woodlands were historically absent, it can be inferred that grassland fires frequently burned into oak woodlands. These fires burned quickly and with low intensity in open oak woodlands with continuous grassy understories. Oak are generally capable of surviving this type of fire (Wright and Bailey 1982), and the herbaceous layer responds quickly. Fires probably thinned these open stands by killing young woody plants that established after the last fire.

Extensive cattle grazing and construction of fire breaks (e.g., roads, pastures, housing developments), in association with efficient fire suppression, may have contributed to greatly reduced fire frequencies after the mid-1800s. (McPherson 1992, Duncan and Clawson, 1979).

2. Habitat Conversions

Oak woodland and oak woodland chaparral communities are often converted to habitats dominated by grasses and forbs to increase grazing potential (Bell and Studinski 1972, Holland 1979, Kay and Leonard 1979, Murphy 1979, Raguse et al. 1984). The removal of oak tree and associated shrub cover is accomplished with fire, cutting, or chemical treatment practices.

GRASSLAND

I. HABITAT TYPE DESCRIPTION

Grassland habitats in California consist of two main types, as defined in the California Wildlife Habitat Relations (WHR) classification: annual grasslands and perennial grasslands (Mayer and Laudenslayer 1988). Annual grassland habitats are open grasslands composed primarily of annual grass species occupying what was once a pristine native grassland. The structure and physiogomy of these grasslands is variable depending on such factors as species composition, weather, season, year and livestock grazing. This habitat type is found throughout the central valley, the coastal mountain ranges north to Mendocino County, and in scattered locations in southern California, ranging in elevation from sea level to 3,900 feet (Kie 1988a).

The perennial grassland type occurs in the coastal prairie form and as relic perennial grasslands (Kie 1988b). The coastal prairie form is found in northern areas of California under maritime influence while the relic perennial forms occur scattered throughout the annual grasslands (Kie 1988a,b). The relics within the annual grasslands are generally small enough to not be considered a separate type. The coastal perennial grasslands are typically found on south slopes and ridges and vary in structure depending on the species composition. This type occurs from Monterey northward along the California coast below

1,000 meters (3,280 feet), and usually within 100 kilometers (62 miles) from the coast.

Virtually no pristine native grasslands remain in California (Kie 1988a). Barbour and Whitworth (1992) estimate that grasslands along the north coast and in the central valley once covered fifteen percent of California. If the oak woodland habitat dominated by a herbaceous understory are counted, then one-fourth of the state's landmass was previously covered by grassland species. There is no good evidence that perennial grasses ever dominated our grasslands except in the North Coast Ranges (Blumler 1993).

II. AVIFAUNA USE

Grasslands contain relatively few bird species (Wiens and Dyer 1975). For instance, Udvardy (1958) reported that only 5.3% of all North American birds are truly grassland species. Johnsgard (1979) listed 36 species that have a breeding distribution generally associated with grasslands, and only 15 of these are endemic to the Great Plains (Graul 1980).

III. DIRECT EFFECTS TO HABITAT

A. Soil Impacts

Under protection from grazing, the undisturbed vegetation, microflora and microfauna of the soil contribute to a granular structure and increased porosity of the soil. An increase in infiltration, percolation and water storage capacity also occur. These factors in turn affected vegetational changes, and possibly a secondary succession towards the perennial grass climax. Thus, that portion of the soil profile which is actually utilized by the plants is deep under protection from grazing (Liacos 1962).

Changes in the physical properties of soils, such as compaction, can occur as a result of grazing. Many of these changes are subtle and occur slowly over time. Rauzi and Smith (1973) noted that grazing can result in soil compaction, but that the effects of the compaction often disappear after seasonal wetting and drying or freezing and thawing.

Overgrazing of grasslands can modify runoff patterns and significantly reduce stream volumes or groundwater supplies (Johnson et al. 1987). The condition of rangeland soils often influences the amount of water intake and loss. Soil characteristics that favor water infiltration are often related to the amount of deterioration of vegetative cover (Anderson 1993). Liacos (1962) noted that undisturbed areas protected from grazing had a granular soil structure with greater porosity than grazed areas. This resulted in a higher infiltration and water storage capacity for ungrazed soils versus heavily grazed soils. Dunford (1949)

suggested that light to moderate grazing intensities increase surface runoff but not erosion, and heavy grazing intensities increase the amount of runoff to the point that erosion was accelerated as well. Liacos (1962) supported that conclusion, noting that the potential for soil erosion in California winter grasslands increases with the intensity of grazing, which causes lower infiltration rates and heavier surface runoff.

Grazing can maintain the productivity of grassland soils by recycling nutrients. Large amounts of standing dead material can be found during summer in years of abundant rainfall and light to moderate grazing pressure (Kie 1988a). Microbial decomposition of dead plant material may be increased by grazing because it causes standing dead material to come in contact with the soil surface. In the absence of grazing, more nutrients might be lost to mechanical breakdown and wind action in arid and semi-arid grasslands (Edwards 1993).

Although a limited disruption of the soil surface by the hoof action of ungulates can create good soil-seed contacts (Edwards 1993), Winkel et al. (1991) found that heavy trampling by cattle may bury many seeds too deep for emergence. They noted that summer rains are capable of burying many small seeds, even on unprepared seedbeds.

B. Water Impacts

Anderson (1993) compiled a list of important factors which influence watershed dynamics. These included vegetation, surface geology, soils, climate, runoff, topography, upland erosion, and channel erosion.

Water penetrates the soil more rapidly and to greater depth beneath a grass cover than under bare soil or areas heavily utilized by livestock (Anderson 1993). Rauzi and Hansen (1966) reported that water infiltration can be as much as 2.5 times higher on lightly grazed rangelands compared to heavily grazed rangelands (Anderson 1993). Anderson (1993) stated that there is a direct relationship between grass cover (height and diameter) and the depth of water penetration. After infiltration, water storage is affected by a number of vegetational factors. The greater the height and cover of the vegetation, the less water is lost by evaporation or wind, and conversely, the greater the vegetative cover the greater the water loss will be due to transpiration (Anderson 1993).

C. Foliage Impacts

Fire, activities of wild herbivores, and climatic variations were the major factors influencing grassland ecosystems under pristine conditions (Kirsch et al. 1979). The introduction of non-native annual plant species, increased grazing pressure, elimination of frequent fires,

and cultivation have caused dramatic changes in grassland species composition and structure (Heady 1977). As a result of past grazing by wild herbivores and fire, many present day bunchgrasses are tolerant of severe grazing, and even show benefits from such activities as grazing, clipping, mowing, or fire (Edwards 1993). In many cases however, grazing has promoted the dominance of alien species by eating native grasses to near extinction while leaving less palatable alien species (Barbour and Whitworth 1992).

Grazing influences species in grass communities directly by effecting plant survival and size, and indirectly by grazing of competitors and alteration of the local environment for plant establishment (Silvertown et al. 1991). Grazing by domestic livestock or wild herbivores such as Roosevelt elk can substantially alter habitat structure through reduction in plant height and removal of biomass.

Vegetation changes caused by grazing, such as the spread of introduced annuals, are slower to occur on the north coast than in the central valley due to a less seasonal climate (Kie 1988ab). Livestock grazing and weather combine to determine the structure of annual grasslands (Kie 1988a). Annual grasses germinate during fall rains and grow slowly during the cool winter months, remaining low in stature until temperatures increase in the spring, stimulating more rapid growth. Low growing forbs that mature in the spring, and summer annuals are both favored by grazing (Kie 1988a). Edwards (1993) noted that grazing may provide beneficial effects to native bunchgrasses by reducing the accumulation of dead residue within the grass bunches. This can lead to increased vigor and greater culm and seed production in natives, which are not as well suited to growing through thatch as the exotic annuals.

D. Succession

Most annual grassland habitats in California now consist of non-native annuals which have effectively prevented native grasses from reestablishing. Kie (1988a) suggests that these annuals comprise climax communities and should be considered naturalized plant communities and managed as such. Barbour and Whitworth (1992) noted that native bunchgrasses often lack the ability to return, even if livestock grazing were limited or removed. Some native perennial grasslands on the north coast now dominated by annuals may have the ability to reestablish under a reduction in grazing pressure (Kie 1988b). Conversely, Blumler (1993) suggested that perennials never dominated California grasslands, except in the North Coast Ranges where the climate is less seasonal, but they were probably present in many areas now lacking them. He noted that globally, there is a greater correlation between the success of Old World invaders and climate than there is between invaders and severe grazing. Many examples of invasion without disturbance

exist, suggesting that natives are often unable to displace aliens, even when an abundant seed pool and a lack of grazing exist (Blumler 1993).

Large ungulates, especially in California, control brush encroachment on grassland, primarily through trampling of the vegetation (Edwards 1993).

IV. INDIRECT EFFECTS TO HABITAT

A. Fire

Grazing by domestic livestock differs fundamentally from grazing by bison or other native ungulates because herds of livestock remain in a restricted area rather than shift across vast landscapes. Domestic livestock exert prolonged and intense grazing pressure that varies with the number of animal per unit area and with the season and duration of their presence. One effect of livestock on northern plains ecosystems has been to greatly reduce fire frequency and intensity by consuming the fine fuels needed to transport fire. The result has been increased invasion of woody plants and the general replacement of intermediate and tallgrass species by more grazing tolerant species of shorter stature. In tallgrass prairie, where fires play a critical role in excluding woody vegetation, livestock grazing has converted many areas into woodlands or shrublands. In mixed grass prairie, fire suppression and cattle grazing result in increased abundance and size of two common shrubs, wolf or snowberry (Symphoricarpos occidentalis) and silverberry (Elaeagnus commutata) (Dopkin 1994).

B. Herbicides

Herbicides are widely used in range management to suppress the growth of unwanted vegetation in order to increase the grazing potential for livestock (Schulz and Leininger 1991).

C. Salt Licks

Salt placement in areas of abundant forage encourage grazing in these areas but did not greatly decrease grazing in areas close to water where licks were not placed (Bryant 1982).

CONIFEROUS FOREST

I. HABITAT DESCRIPTION

The coniferous forest habitat type is extensive throughout California at elevations above 770 meters in the north and 1200 meters in the south. Various conifer species dominate these communities, and understories usually consist of hardwoods and/or other conifer species. The shrub and herbaceous layers range from sparse to dense, depending on canopy coverage, elevation, and climatic factors. The conifer dominated habitats found in Region 5 are subalpine conifer, red fir, lodgepole pine, Sierran mixed conifer, white fir, Klamath mixed conifer, Douglas-fir, Jeffrey pine, ponderosa pine, and eastside pine. The Guide to Wildlife habitats of California (Mayer and Laudenslayer 1988) contains detailed descriptions of these habitat types.

II. AVIFAUNA USE

Many species of birds occur throughout coniferous forests in western North America regardless of the tree species that dominate the plant community. Verner (1980) noted that seventy-two bird species are predicted to breed in various habitat stages of mixed-conifer forests in the western Sierra Nevada. In general, all climax forests in North America are characterized by comparatively few birds except where these forests come in contact with subclimax vegetation (Smith 1980).

Bird species richness tends to increase with increasing horizontal heterogeneity of the vegetation (patchiness) and with addition of layers of vegetation (shrubs, trees) (Verner 1980). Wilson (1974) concluded (in part) that the mere presence of a tree layer is more closely associated with species addition than is the total amount of foliage or its distribution (Smith 1980). The more layers of foliage in the vegetation, and the more evenly the layers are distributed vertically, the higher will be the bird species diversity (Verner 1980).

III. Direct Effects to Habitat

The effects of cattle grazing have been felt for over 125 years throughout national forests in the west. The impacts of cattle use on forested range is controlled by an interaction of factors including topography, vegetation type, climate, availability of water and livestock behavior (Roath and Krueger 1982).

A. Water and Soil Impacts

Roath and Krueger's (1982) observations of cattle distribution on their study unit indicated that water was a primary factor in determining cattle use patterns. Water appeared to be the central point of distribution, with all the animals returning to a watering area at least once per day. In the absence of other influencing factors that might limit cattle distribution,

distance from water ultimately controls the limit of vegetation utilization (Roath and Krueger 1982).

Grazing in seeded clearcuts is beneficial to tree growth only if soil moisture is a limiting factor. Edgerton's (1971) findings of no substantial increase in tree growth on grazed plantations seeded with annual grasses indicate that sites with high soil water retention and availability show no need for intentional grazing by cattle.

B. Foliage and Canopy Impacts

Grazing impacts foliage in all canopy layers in the coniferous forest habitat type. Levels of use by livestock in mixed coniferous forests are largely dependent upon the overstory canopy cover and the amount of herbaceous vegetation present in the understory (Hedrick et al. 1968, Miller and Krueger 1976). Miller and Krueger (1976) found that tree canopy cover accounted for ninety-eight percent of the variation in herbaceous plant yield in the understory. The lodgepole pine type and the portions of the Douglas-fir type which had a north aspect received neglible amounts of use.

Holechek and Vavra (1983), in a study conducted in the Blue Mountains of eastern Oregon, found that shrub species were relatively unavailable in open grassland areas, but were an important part of the understory in forested areas. About 20 percent of the grassland pasture supported a very open stand of ponderosa pine with an understory of Idaho fescue and common snowberry. Their results indicated that in the afternoon, forest grazing cattle preferred the more heavily forested areas dominated by Douglas-fir in the overstory and by elk sedge and common snowberry in the understory. During the morning hours however, cattle preferred to graze forest openings dominated by Idaho fescue and bluebunch wheatgrass. Doescher et al. (1987) found that livestock will preferentially select grasses when they are green and succulent. Forbs and shrubs are consumed with greater frequency as the graminoid component matures and dies. Therefore, grazing must be timed to reduce the vigor of competing vegetation, maximize moisture and nutrients for tree growth, and minimize browsing of conifer seedlings (Doescher et al. 1987).

Leininger (1983) suggests that plantation grazing is most effective when it occurs before or after conifer bud break in order to avoid the loss of carbohydrate reserves to the young seedlings. Doescher et al. (1987) find it possible to minimize damage to conifer seedlings if adequate quantities of preferred forage is available at the time of grazing. Edgerton (1971) reported only light grazing damage to conifer seedlings in a ponderosa pine plantation in Oregon when the cattle were removed by midsummer. Ample forage was still available at this point, and cattle were removed before the less palatable seedlings were damaged (Edgerton 1971). Kingery et al. (1987) found that the intensity of livestock

utilization and the management of the stock was related to the level of resultant damage. Direct damage from livestock varied from no trees damaged on a site at 27 percent utilization to 5.8 percent damage on a site at 81 percent utilization.

In a closely managed grazing system, livestock can provide a low-cost means for controlling competing vegetation in conifer plantations (Doescher et al. 1987). Sharrow et al. (1992) states that the effects of grazing on tree growth generally represent a balance between the negative impacts of browsing and trampling of seedlings compared to the positive effects of reduced competition between planted trees and other vegetation in the plantation. Doescher et al. (1987) list certain parameters which must be met when using grazing animals to suppress competing vegetation. Palatable forage must be available to minimize conifer damage; in areas where moisture is limited during the growing season, vegetation should be grazed before stored soil moisture is depleted; animal numbers and their distribution must be controlled to reduce browsing and trampling damage and ensure uniform vegetation control; and costs of implementing a grazing program must be minimized. Urness (1979) points out the limitatations of this type of management activity, where the effective foraging period for livestock is from 15 to 20 years on unthinned plantations, with the peak utilization at 11 years. Basile (1975) concurs with this observation when applied to unmanaged lodgepole pine forests, citing the lack of palatable native plants and minimal forage production.

C. Succession and Reproduction

The primary effect of grazing on the reproduction and seral succession of conifers is the reduction of competing vegetation in both plantations and natural stands. Sharrow et al. (1992) found that sheep grazing effectively reduced competing vegetation (mainly red alder) in a Douglas-fir plantation in coastal Oregon, but the increase in growth was not apparent until 3 years post-grazing, when the trees were 5-6 years old. Sharrow speculates that the delay in growth response is due to the initial browsing impacts of the sheep, coupled with the increase in competition between the conifer and red alder seedlings as they grew. This finding may account for Edgerton's (1971) data, where average tree heights of ponderosa pine seedlings did not show significant growth after 5 growing seasons, indicating a lack of beneficial effects from grazing.

IV. INDIRECT EFFECTS TO HABITAT

A. Salt Licks

The placement of salt supplements can be critical to the pattern of vegetation use by cattle. Roath and Krueger (1982) found that in dry years, cattle would trail from water to

salt and back, without bedding in the vicinity of the salt block. In wet years, however, when water was more readily available and the vegetation more lush, cattle remained at the salt block area for longer periods, creating a heavier use impact on adjacent vegetation.

B. Roads

Roath and Krueger (1982) also noted the extensive use of logging road networks by cattle, allowing easier distribution and travel through steep and rugged terrain. This easy access to normally inaccessible areas facilitated the grazing impacts of roadside vegetation above and below the roads.

C. Fire

With forested landscapes in general, the impacts of livestock grazing tend to be concentrated in drainage bottoms, wet meadows, and grassy slopes (Bock et al. 1994). A major consequence of livestock grazing has been the removal of much herbaceous vegetation that provided fine fuels necessary to carry frequent, low intensity fires. Domestic livestock, in conjunction with active fire suppression, have caused a widespread transformation of these woodlands into dense forests with a decreased understory of herbaceous plants. One result of this transformation is the accumulations of heavy fuels that can now produce catastrophic fires resulting in widespread tree mortality (Bock et al. 1994, Madany and West 1983, Madany 1981).

D. Range Improvements

The increase in perch and nesting sites provided by structures such as fences and windmills and water developments such as springs, wells and stock ponds can create new habitat for many bird species (Kochert 1989).

EFFECTS TO AVIFUANA

Several studies have been done concerning grazing and birds in various habitat types. Bock et al (1994) and Dopkin (1994) both compared studies done in riparian, grassland and coniferous forests in an attempt to find consistency between studies and measures by which to assess effects from livestock grazing, specifically on neotropical migratory birds. Bock et al's (1994) analysis on grazing impacts on neotropical birds in riparian habitat found two main difficulties pertaining to the study designs: 1) a shortage of long term studies and 2) uncertainty as to what pre-livestock condition of plant communities were.

Dopkin's (1994) analysis of grazing on grassland birds showed that several studies compared breeding bird communities among different grazing regimes, but these studies were across qualitative assessments of grazing intensities (heavy, moderate and light). Dopkin also felt it was impossible to evaluate results meaningfully across studies as there were no long term studies for grassland nesting species and no studies explicitly to compare population productivity among disturbed, grazed, burned and hayed grasslands.

Bock et al. (1994) indicated that virtually nothing is known about the impacts of livestock on neotropical migratory birds associated with western coniferous forests. No native ungulate herds in any way comparable to sheep or cattle have co-evolved with the vegetation of coniferous forests (Dopkin 1994). Though many studies have been done on grazing within oak woodlands, few studies exist for impacts on neotropical birds utilizing this habitat type. Those studies that do exist, have similar concerns with their study design as described previously for the riparian and grassland habitats.

Despite the concerns with assessing grazing impacts on birds, based on existing studies, assumptions can be drawn based on an individual bird's need for specific habitat elements. The previous sections dealt with bird use in habitat types as well as livestock grazing impacts to those habitats. To summarize the impacts on vegetation that birds may need for nesting, shelter and foraging, it has been shown that livestock influence wildlife habitat by modifying plant vigor, modifying plant biomass, modifying structural components such as vegetative height and cover, and modifying plant species compositions (Kie and Loft, 1990). These changes in vegetation have been related to the increase or decline of various species of birds (Bock and Webb, 1984).

I. Nesting Effects

Impacts to vegetation can reduce nesting substrate (Kochert 1989) for avian species. Species specialized in their selection of nesting sites would be intolerant of habitat alteration whereas those species generalized in their selection would better tolerate changes in nesting substrate. Species that prefer certain nesting substrates but can use alternate types may still persist after habitat alteration, however their densities may decline over time (Stauffer and Best 1980). Table One displays the nest substrate utilized by neotropical migratory birds. All Tables utilize information obtained from Erhlich et al. (1988) and the Neotropical Migratory Reference Handbook (1994).

Table One breaks down nesting substrate into eight categories: ground (bare ground and herbaceous layer), banks (burrows), shrub, coniferous trees, deciduous trees, cavities, cliffs and development (artificial habitat created by humans). Effects to avian species from

livestock grazing on preferred nesting substrate are broken down into individual nesting substrate categories. Ground nesters (bare ground) and bank nesters have been lumped together due to similar effects from livestock grazing.

A. Ground Nesters

1. Bare Dirt/Banks/Burrows

There are eight species of neotropical migrants that utilize bare ground as a nesting substrate either by nesting directly on it (nighthawk and poorwill species), burrows beneath the surface (burrowing owl) or in burrows in streambanks (belted kingfisher, bank and rough-winged swallows).

Effects on soil stability (erosion and compaction) as a result of trampling by livestock has the potential to impact species utilizing streambanks or the ground for placement of nests in burrows. Weakening of the soil can collapse burrows resulting in nest failure through crushing or suffocation of eggs and young. Entrapment may lead to egg loss through lack of thermal cover, and/or starvation of young, if the adults cannot reenter the burrow. Adults trapped during incubation or feeding may also perish if they can not excavate an exit. Habitat loss for a species through continued soil erosion and bank instability can be critical for declining species, especially a colonial species, such as the bank swallow.

Some ground nesting birds utilizing bare ground or having a security need for predator detection can benefit from reduced vegetative cover from grazing. Certain raptors such as the burrowing owl require bare ground and are probably benefitted by grazing (Bock et al. 1994) which reduces vegetation around and in the vicinity of the burrow entrance. This helps facilitate predator and prey detection as well as maintaining the opening of the burrow entrance. The nighthawk is another species that nests on bare ground and may benefit from heavy grazing that removes ground vegetation (Ryder 1980). The same may be expected for poorwill species that utilize similar nesting substrate as the nighthawks.

2. Herbaceous Layer

Excluding the cowbird, twenty-five species utilize the herbaceous layer as a nest substrate. Grazing can impact ground nesting birds through trampling of nests and the reduction of vegetation which is needed for nests and security cover from predators (Kochert 1989). Bird species use different strata of vegetation and these layers have different vulnerabilities to grazing. The lower strata can be affected by short term grazing (Taylor 1986) which can affect avian species that utilize the herbaceous or bare ground for nest placement (Szaro 1980).

In riparian zones, livestock remove (to varying degrees depending on the timing, duration and number of livestock) the lower vegetation layers (Bock et al. 1994). Saab et. al (1995) compared impacts to species from grazing based on nest location and concluded that ground nesting species were the most susceptible to disturbance from livestock grazing. Species particularly affected based on study comparisons were the dark-eyed junco, white-crowned, savannah and Lincoln's sparrows (Saab et al. 1995), short-eared owl and northern harrier (Kochert 1989). Mortality during the breeding season on montane meadows can also occur from trampling of nests by sheep and horses (Samson 1988).

In grasslands, some species will respond positively whereas others will respond negatively to livestock grazing, depending on the type and condition of grassland (Dopkin 1994). For example, the small amount of grazing that can be used to create ideal habitat for a species in a tallgrass prairie may be equally certain to destroy the same species habitat in a shortgrass steppe or semidesert grassland (Saab et al. 1995). Studies on impacts to grasslands have primarily been done in association with the great plains but some comparison can be done for species that occur in both western and great plains grasslands.

Some birds require or prefer intermediate amounts of grass cover and have benefited from grazing in tallgrass and some mixed grass communities but declined or disappeared in the presence of grazing in shorter grasslands. These species include the grasshopper sparrow and the red-winged blackbird (Saab et al. 1995).

Species that were shown to benefit from grazing include lark and black-throated sparrows whereas those that have been negatively affected are the common yellowthroat and savannah's sparrow. Western meadowlarks appear to tolerate all except the heaviest of livestock grazing (Saab et al. 1995).

A benefit for some species from livestock is when grazing causes the parts of plants beneath the ground to be reduced resulting in denser growing individual grasses. This may provide better cover and nesting sites for birds (Ryder 1980).

Faane (1987) documented a correlation between avian species diversity and foliage volume in the "high ground layer" which consisted of taller grasses and forbs, larger woody seedlings and young shrubs. This is the first layer to be impacted by cattle grazing occurring in wooded draws (Dopkin 1994). In Bock et al.'s (1994) analysis of coniferous forest impacts, it was speculated that the birds mostly likely to be negatively affected were those that were dependent on the herbaceous ground cover for nesting. Species likely to be affected by a loss of nesting substrate would be the hermit thrush, nashville warbler, Lincoln's and fox sparrows (Saab et al. 1995).

C. Shrub Nesters

Forty-three species utilize shrubs for nest placement. Undisturbed willow riparian areas with tall and voluminous shrubs support large populations and more species of birds. Birds and shrubs both decrease with increased frequency of grazing (Taylor 1986). Birds that are affected by livestock in riparian areas are species that nest in dense shrub layers (Bock et al. 1994, Dopkin 1994). Bull and Skovlin (1982) found that lack of deciduous woody vegetation was associated with low numbers of birds that utilize this type of cover.

Grazing causes notched or highlined willows that are top-heavy with high branches but with few live branches underneath (Taylor and Littlefield 1987). This affects the nesting substrate of species such as the willow flycatcher which nests within two meters of the ground (Serena 1982). Willow flycatchers and yellow warblers were found to be more abundant in rarely grazed or completely undisturbed willow areas (Taylor 1986). Common yellowthroats and yellow breasted chats occupy habitat with heavy vegetation coverage and density and are likely to be species most sensitive to vegetation removal. They would be the first in a progression of species to drop out of an improperly grazed riparian system. American robins are probably least sensitive to herbage removal since they occur on sites of lower vegetation density and coverage. Robins may drop out of the grazed riparian ecosystem after most of the other species or might not drop out at all (Sedgwick and Knopf 1987).

In coniferous forests, the rufous-sided towhee utilizes low brushy vegetation. The removal of white fir thickets and incense cedar thickets negatively affected the presence of the species in a Sequioa forest (Kilgore 1970). Similar effects may occur from impacts to conifer seedlings and saplings from livestock where trampling and browsing reduce or eliminate this vegetative layer in the understory.

D. Tree Nesters

Sixty-six species of neotropical migratory birds nest in trees. Impacts to the overstory would be expected to affect overstory dependent birds. However, habitat alterations, including moderate, late-fall grazing may be deceptive in the short term as avian densities remaining relatively unaffected while avian productivity is reduced in the long term (Sedwick and Knopf 1987).

Cattle grazing in riparian areas over several decades can eliminate or reduce the upper canopy by preventing the establishment of saplings (Taylor 1986). Grazing suppresses the regeneration of cottonwood, aspen and other trees used by raptors and other avian species for nesting. Heavy grazing pressure eventually results in decadent and senescent, even-aged, non-reproducing stands with few nest trees large enough for raptor

species (Kochert 1989). The combination of decreased establishment and normal mortality of the mature trees would eventually either severely reduce in number or eliminate cottonwoods from the forest (Kochert 1989, Ryder 1980), resulting in impacts to avian species dependent on this type of nest substrate.

In open areas, cattle congregrate in grasslands with small tree groves for shade, and trampling and abrasion by livestock may kill trees resulting in the loss of nest trees for birds, especially raptors (Kochert 1989, Ryder 1980).

E. Cavity Nesters

Good and Dambach (1943) noted little affect of grazing on hole nesters (Ryder 1980). As a group (15 species), cavity nesters have been essentially unaffected (Bock et al. 1994). However, indirect effects to cavity nesters will occur through the lack of tree regeneration within aging cottonwood forests and other areas where succession is affected. This will lead to the loss of live trees that serve as future replacement for existing snags, resulting in significant declines of cavity-nesting species (Dopkin 1994). Saab et al. (1995) also noted that trampling and browsing of young trees can limit the number of trees that reach maturity, thus reducing future canopy layers which will ultimately affect the number of snags available for cavity nesters to utilize.

An indirect impact of livestock grazing is the decreased availability of nesting and roosting cavities in standing snags as a result of the reduction in fire frequency due to diminished fine fuels (Saab et al. 1995).

Through reduction in ground vegetation, one species that consistently increased with grazing across habitats was the mountain bluebird (Saab et al. 1995). This may be the result of improved foraging habitat from reduction of ground cover near available nesting habitat. Many short distance migrants are cavity nesters, whose nesting sites do not appear to be affected by grazing in the short term. Long distance migrants however appear more susceptible to grazing. This may be due to being energy stressed upon arrival at the breeding grounds, and thus more vulnerable to human related disturbances (Saab et al. 1995).

F. Cliff Nesters

Habitat of this type is not accessed by livestock and therefore it can be anticipated that direct impacts to nesting substrate for birds such as prairie and peregrine falcons would be nonexistant. Though studies have not been conducted on this species for grazing impacts, alterations to streams that could affect waterflow could play a part in altering the

microclimate provided by waterfall spray for nesting black swifts.

Ryder (1980) found gullies accelerated in their development by intensive grazing provided nest sites in the form of crevices for Say's phoebe and rough-winged swallows.

G. Artificial Habitat

Human developments in the form of fences, windmills and other structures provide perches and nesting platforms, although raptors may collide with them (Kochert 1989, Martin 1984). Buildings, especially barns also provide nesting substrate for barn swallows and other species that utilize human developments. Ten species have been shown to use artificial habitat. Caution should be made in regards to considering artificial habitat as suitable nesting substrate for birds. Even though some species will utilize it, it should not be considered a suitable substitute for natural habitat. It can however, be used as a short term replacement for natural habitat until suitable habitat can be re-established.

TABLE ONE

	NEST PLACEMENT				NEST PLACEMENT			
BIRD SPECIES	Ground	Bank	Shrub	Conifer	Decidus	Cavity	Cliff	Devplt
Turkey Vulture							X	
Osprey				X	X		X	
Northern Harrier	X		X					
Sharp-Shinned Hawk				X	X			
Cooper's Hawk				X	X			
Northern Goshawk				X	X			
Red-Shouldered Hawk				X	X			
Swainson's Hawk					X		X	
Red-Tailed Hawk				X	X		X	
Ferruginous Hawk				X			X	
Golden Eagle				X			X	
American Kestrel						X	X	
Merlin					X		X	
Peregrine Falcon				X	X		X	
Prairie Falcon							X	
Band-Tailed Pigeon				X	X			
White-Winged Dove					X			
Yellow-Billed Cuckoo			X		X			
Flammulated Owl						X		
Burrowing Owl	X							
Long-Eared Owl	X				X			
Short-Eared Owl	X							
Lesser Nighthawk	X							
Common Nighthawk	X							
Common Poorwill	X							

TABLE ONE

	NEST PLACEMENT				NEST PLACEMENT			
BIRD SPECIES	Ground	Bank	Shrub	Conifer	Decidus	Cavity	Cliff	Devplt
Whip-Poor-Will	X							
Black Swift							X	
Vaux's Swift						X		X
White-Throated Swift						X	X	X
Black-Chinned Hummingbird					X			
Anna's Hummingbird			X		X			
Costa's Hummingbird			X		X			
Calliope Hummingbird			X	X	X			
Broad-Tailed Hummingbird				X	X			
Rufous Hummingbird				X	X			
Allen's Hummingbird			X		X			
Belted Kingfisher		X				X		
Lewis' Woodpecker						X		
Red-Naped Sapsucker						X		
Red-Breasted Sapsucker						X		
Williamson's Sapsucker						X		
Olive-Sided Flycatcher				X				
Western Wood-Pewee				X				
Willow Flycatcher			X		X			
Hammond's Flycatcher				X	X			
Dusky Flycatcher			X	X	X			
Gray Flycatcher			X		X			
Western Flycatcher	X				X		X	

TABLE ONE

	NEST PLACEMENT				NEST PLACEMENT			
BIRD SPECIES	Ground	Bank	Shrub	Conifer	Decidus	Cavity	Cliff	Devplt
Say's Phoebe							X	X
Vermillion Flycatcher					X			
Ash-Throated Flycatcher						X		X
Brown-Crested Flycatcher						X		
Cassin's Kingbird					X			
Western Kingbird			X		X			X
Eastern Kingbird			X		X			
Purple Martin						X	X	X
Tree Swallow						X		X
Violet-Green Swallow						X		X
Northern Rough-Winged Swallow		X					X	X
Bank Swallow		X						
Cliff Swallow							X	X
Barn Swallow								X
Pinyon Jay				X				
House Wren						X		
Marsh Wren			X					
Golden-Crowned Kinglet				X				
Ruby-Crowned Kinglet				X				
Blue-Gray Gnatcatcher					X			
Swainson's Thrush			X	X				
Hermit Thrush	X			X	X			
American Robin				X	X			X
Varied Thrush				X				
Sage Thrasher	X		X					

TABLE ONE

BIRD SPECIES	NEST PLACEMENT				NEST PLACEMENT			
	Ground	Bank	Shrub	Conifer	Decidus	Cavity	Cliff	Devplt
Bendire's Thrasher			X		X			
Water Pipit	X							
Cedar Waxwing				X	X			
Loggerhead Shrike			X		X			
Bell's Vireo			X					
Gray Vireo			X					
Solitary Vireo				X	X			
Warbling Vireo			X		X			
Orange-Crowned Warbler	X							
Nashville Warbler	X							
Virginia's Warbler	X							
Yellow Warbler			X	X				
Yellow-Rumped Warbler				X				
Black-Throated Gray Warbler				X	X			
Townsend's Warbler				X				
Hermit Warbler				X				
MacGillivray's Warbler	X		X					
Common Yellowthroat			X					
Wilson's Warbler	X							
Yellow-breasted Chat			X					
Summer Tanager				X	X			
Western Tanager				X				
Black-Headed Grosbeak			X		X			
Blue Grosbeak			X		X			

TABLE ONE

BIRD SPECIES	NEST PLACEMENT				NEST PLACEMENT			
	Ground	Bank	Shrub	Conifer	Decidus	Cavity	Cliff	Devplt
Lazuli Bunting			X					
Green-Tailed Towhee	X		X					
Rufous-Sided Towhee	X		X					
Rufous-Crowned Sparrow	X		X					
Chipping Sparrow				X	X			
Brewer's Sparrow			X					
Black-Chinned Sparrow			X					
Vesper Sparrow	X							
Lark Sparrow	X		X					
Black-Throated Sparrow			X					
Sage Sparrow	X		X					
Savannah Sparrow	X							
Grasshopper Sparrow	X							
Lincoln's Sparrow	X							
White-Crowned Sparrow	X		X					
Dark-Eyed Junco	X							
Red-Winged Blackbird			X					
Western Meadowlark	X							
Yellow-Headed Blackbird			X					
Brewer's Blackbird	X		X	X				
Brown-Headed Cowbird	X		X		X			
Hooded Oriole					X			
Northern Oriole					X			
Scott's Oriole			X		X			
Cassin's Finch				X				

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TABLE ONE

BIRD SPECIES	NEST PLACEMENT				NEST PLACEMENT			
	Ground	Bank	Shrub	Conifer	Decidus	Cavity	Cliff	Devplt
Pine Siskin				X	X			
Lesser Goldfinch			X		X			
Lawrence's Goldfinch			X		X			
American Goldfinch			X		X			

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II. Effects to Forage

Neotropical birds are primarily insectivores and migrate when their food source is decreased during inclement weather. Other species such as raptors that rely on larger prey also may migrate in search of prey. Nectivores, frugivores and granivores migrate to areas where they can obtain food. Table Two shows the food preference of species utilizing vegetative matter in their diets and Table Three shows species that have insects or vertebrates in their diet. Neotropical migrant bird species may appear on both tables as many species have a varied diet. Table Four shows foraging style(s) of the neotropical migrants. Birds may be impacted first by their style of foraging before they are affected by lack of prey. For example species that glean the lower vegetation for insects will be impacted if the lower vegetation is absent for them to glean from unless they are capable of utilizing an alterate foraging style such as ground or aerial foraging for insects.

A. Vegetative Diet

Medin and Clary (1989) found that ungrazed communities were preferred by birds of herbivorous and granivorous foraging guilds.

Many species respond differently to the effects of grazing in different grassland types, and certain species may require grasslands in different condition to meet different life requirements (e.g., foraging vs nesting (Bock and Bock 1988). For example, ferruginous hawks showed a mixed response to grazing, apparently preferring to hunt open grasslands but to nest in areas with ground cover or with scattered large trees (Saab et. al. 1995).

In coniferous forests, we can only speculate that the birds most likely to be negatively affected by livestock grazing are: (1) those species dependent on herbaceous and shrubby ground cover for foraging and (2) species requiring open savannahs as opposed to closed canopy forests. Likely examples from the first group include the hermit thrush, Nashville warbler, fox and Lincoln's sparrow; examples from the second group include the Lewis' woodpecker, violet-green swallow and mountain bluebird (Saab et al. 1995).

A reduction in suitable foraging habitat for ground nesting species may be the most likely form of livestock induced negative impact experienced by migratory landbirds within western coniferous forest (Saab et al. 1995).

Species dependent upon food resources produced directly (nectivores) or indirectly (omnivores) by understory plants were less represented in studies comparing grazed versus ungrazed treatments. Similar responses to grazing by these guilds were observed on tropical wintering grounds of migratory landbirds (Saabe et al. 1995) as well as on

resident tropical hummingbirds (Martin 1984). Local reductions in nectivores and omnivores could have widespread effects because these species are important pollinators and seed dispersers (Saab et al. 1995).

TABLE TWO

BIRD SPECIES	FOOD PREFERENCE				FOOD PREFERENCE			
	Berries	Fruit	Nectar	Sap	Buds	Nuts	Seeds	Grain
Band-Tailed Pigeon	X					X		X
White-Winged Dove	X	X					X	X
Black-Chinned Hummingbird			X					
Anna's Hummingbird			X					
Costa's Hummingbird			X					
Calliope Hummingbird			X					
Broad-Tailed Hummingbird			X					
Rufous Hummingbird			X					
Allen's Hummingbird			X					
Lewis' Woodpecker	X	X				X	X	
Red-Naped Sapsucker	X	X		X				
Red-Breasted Sapsucker		X		X				
Williamson's Sapsucker	X			X				
Western Wood-Pewee	X							
Willow Flycatcher	X						X	
Western Flycatcher	X						X	
Say's Phoebe	X							
Ash-Throated Flycatcher	X							
Brown-Crested Flycatcher	X							
Cassin's Kingbird	X							
Western Kingbird	X	X						
Eastern Kingbird		X						
Tree Swallow	X							
Cliff Swallow	X							
Barn Swallow	X							

TABLE TWO

BIRD SPECIES	FOOD PREFERENCE				FOOD PREFERENCE			
	Berries	Fruit	Nectar	Sap	Buds	Nuts	Seeds	Grain
Pinyon Jay		X				X	X	X
Golden-Crowned Kinglet		X		X			X	
Ruby-Crowned Kinglet	X			X			X	
Swainson's Thrush	X	X						
Hermit Thrush		X						
American Robin		X						
Varied Thrush		X				X	X	
Sage Thrasher	X	X						
Bendire's Thrasher		X						
Water Pipit	X						X	
Cedar Waxwing	X	X		X				
Warbling Vireo	X							
Bell's Vireo		X						
Solitary Vireo		X						
Orange-Crowned Warbler	X							
Yellow-Rumped Warbler	X							
Yellow Warbler	X							
Townsend's Warbler				X			X	
Common Yellowthroat	X						X	
Wilson's Warbler	X							
Yellow-Breasted Chat	X							
Summer Tanager		X						
Western Tanager		X			X			
Black-Headed Grosbeak		X			X		X	
Blue Grosbeak		X					X	X

TABLE TWO

	FOOD PREFERENCE				FOOD PREFERENCE			
BIRD SPECIES	Berries	Fruit	Nectar	Sap	Buds	Nuts	Seeds	Grain
Lazuli Bunting							X	
Green-Tailed Towhee	X						X	
Rufous-Sided Towhee	X	X				X	X	
Rufous-Crowned Sparrow	X				X		X	
Chipping Sparrow							X	
Brewer's Sparrow							X	
Black-Chinned Sparrow							X	
Vesper Sparrrow							X	
Lark Sparrow							X	
Black-Throated Sparrow							X	
Sage Sparrow							X	
Savannah Sparrow							X	
Grasshopper Sparrow							X	
Lincoln's Sparrow							X	
White-Crowned Sparrow	X	X					X	
Dark-Eyed Junco	X						X	
Red-Winged Blackbird							X	
Western Meadowlark		X					X	
Yellow-Headed Blackbird							X	
Brewer's Blackbird		X					X	
Brown-Headed Cowbird							X	X
Hooded Oriole		X	X					
Northern Oriole		X	X		X			
Scott's Oriole	X	X	X					
Cassin's Finch	X				X			

TABLE TWO

BIRD SPECIES	FOOD PREFERENCE				FOOD PREFERENCE			
	Berries	Fruit	Nectar	Sap	Buds	Nuts	Seeds	Grain
Pine Siskin					X		X	
Lesser Goldfinch							X	
Lawrence's Goldfinch							X	
American Goldfinch	X				X		X	

II. Effects to Forage (continued)

B. Animal Diet

Prey species respond to grazing impacts on habitat which results from changes in vegetational diversity and life form composition. Grazing may create suitable conditions for some prey species while destroying conditions for others. Grazing can also affect prey vulnerability through the reduction of vegetative cover. Different prey species respond differently to grazing with their responses varying with the intensity, location and season of grazing (Kochert 1989). Table Three depicts prey groups that are part of the diet of various neotropical migrant landbirds.

1. Invertebrates

Studies on the relationship between birds, insects and grazing come primarily from grassland and riparian habitat types. Insects are important to birds as an available food source (Krueger and Anderson 1985). Grazing can affect the abundance and availability of insects that serve as prey for many species of birds (Ryder 1980) in all habitat types.

a. Terrestrial

Grazing has a differential effect on avian foraging guilds. Aerial and bark insectivores are probably not greatly affected. Aerial insectivores do not rely upon vegetation for feeding substrates and bark insectivores exploit a substrate generally not used by cattle (Saab et al. 1995). However, these species do need either trees or other perches to hunt from or in the case of bark insectivores trees to hunt on. Price (1975) found that the increase in grassland vegetation contributes to habitat diversity which in turn can increase the diversity of the insect community (in Krueger and Anderson date 1985).

Medin and Clary (1989), found that grazed communities were preferred by birds of insect foraging guilds in their study. However, over half the species in the ground foraging insect guild were represented by birds (e.g., American robin) that can utilize human altered habitats.

Grasshoppers comprise an important component of the diet of grassland birds and ungrazed areas typically support higher populations of the insects, in a study done in Missouri, than in ungrazed areas (Ryder 1980). Chronic livestock grazing on shortgrass and mixed grass prairie alters the structure and composition of plant communities in ways that greatly enhance conditions for population outbreaks of grasshoppers. Grasshopper

populations are typically controlled with pesticides and managers concerned with maintaining or enhancing populations of neotropical migrants in native grasslands should consider the elimination of pesticide applications. As rangeland conditions improve, these grasslands will become increasingly unlikely to support grasshopper outbreaks and will provide conditions that should allow predation by grassland birds to effectively maintain grasshopper populations at low or moderate densities (Bock et al. 1994).

b. Aquatic

Streamside vegetation provides habitat for terrestrial insects which are important food items for salmonids and avian species. This vegetation also directly provides organic material to the stream, which makes up about 50% of the stream's nutrient energy supply for the food chain (Cummins 1974). Detritus from incoming terrestrial plants is a principal source of food for aquatic invertebrates that eventually become food (Minshall 1967) for vertebrate predators. Removal of streamside vegetation can reduce habitat for invertebrates by reducing production of both terrestrial and aquatic insects.

Sedimentation caused by erosion and compaction can cover and plug interstitial spaces on the stream bed and prevent use by aquatic species (Kolvalchik and Elmore 1992). Sedimentation can also adhere to and cover the insects either killing them or preventing emergence into the adult form. E coli bacteria from livestock fecal matter can adhere to the gills of aquatic macroinvertebrates and possibly kill the insects (Doloff 1995, unpublished data). The loss of emergent adults throughout the season will reduce a vital food source for birds especially riparian obligate species such as Wilson's warbler, which nests and feeds exclusively in riparian habitat.

TABLE THREE

BIRD SPECIES	FOOD PREFERENCE				FOOD PREFERENCE			
	Insects	Birds	Rodents	Rabbits	Amphibn	Reptile	Fish	Carrion
Turkey Vulture								X
Osprey							X	
Northern Harrier			X		X	X		
Sharp-Shinned Hawk		X						
Cooper's Hawk		X	X	X	X	X		
Northern Goshawk		X	X	X	X	X		
Red-Shouldered Hawk	X	X	X	X	X	X		
Swainson's Hawk	X	X	X	X	X	X		
Red-Tailed Hawk	X	X	X	X		X		
Ferruginous Hawk	X	X	X	X		X		
Golden Eagle	X	X	X	X		X		
American Kestrel	X	X	X		X	X		
Merlin	X	X	X					
Peregrine Falcon		X						
Prairie Falcon	X	X	X	X		X		
Yellow-Billed Cuckoo	X							
Flammulated Owl	X							
Burrowing Owl	X	X	X			X		
Long-Eared Owl		X	X					
Short-Eared Owl	X	X	X					
Lesser Nighthawk	X							
Common Nighthawk	X							
Common Poorwill	X							
Whip-Poor-Will	X							
Black Swift	X							

TABLE THREE

	FOOD PREFERENCE				FOOD PREFERENCE			
BIRD SPECIES	Insects	Birds	Rodents	Rabbits	Amphibn	Reptile	Fish	Carrion
Vaux's Swift	X							
White-Throated Swift	X							
Black-Chinned Hummingbird	X							
Anna's Hummingbird	X							
Costa's Hummingbird	X							
Calliope Hummingbird	X							
Broad-Tailed Hummingbird	X							
Rufous Hummingbird	X							
Allen's Hummingbird	X							
Belted Kingfisher							X	
Lewis' Woodpecker	X							
Red-Naped Sapsucker	X							
Red-Breasted Sapsucker	X							
Williamson's Sapsucker	X							
Olive-Sided Sapsucker	X							
Western Wood Pewee	X							
Willow Flycatcher	X							
Hammond's Flycatcher	X							
Dusky Flycatcher	X							
Gray Flycatcher	X							
Western Flycatcher	X							
Say's Phoebe	X							
Vermillion Flycatcher	X							
Ash-Throated Flycatcher	X							
Brown-Crested Flycatcher	X							

TABLE THREE

	FOOD PREFERENCE				FOOD PREFERENCE			
BIRD SPECIES	Insects	Birds	Rodents	Rabbits	Amphibn	Reptile	Fish	Carrion
Cassin's Kingbird	X							
Western Kingbird	X							
Eastern Kingbird	X							
Purple Martin	X							
Tree Swallow	X							
Violet-Green Swallow	X							
Northern Rough-Winged Swallow	X							
Bank Swallow	X							
Cliff Swallow	X							
Barn Swallow	X							
Pinyon Jay	X	X						
House Wren	X							
Marsh Wren	X							
Golden-Crowned Kinglet	X							
Ruby-Crowned Kinglet	X							
Blue-Gray Gnatcatcher	X							
Swainson's Thrush	X							
Hermit Thrush	X				X			
American Robin	X							
Varied Thrush	X							
Sage Thrasher	X							
Bendire's Thrasher	X							
Water Pipit	X							
Cedar Waxwing	X							

TABLE THREE

	FOOD PREFERENCE				FOOD PREFERENCE			
BIRD SPECIES	Insects	Birds	Rodents	Rabbits	Amphibn	Reptile	Fish	Carrion
Loggerhead Shrike	X	X	X			X		X
Bell's Vireo	X							
Gray Vireo	X							
Solitary Vireo	X							
Warbling Vireo	X							
Orange-Crowned Warbler	X							
Nashville Warbler	X							
Virginia's Warbler	X							
Yellow Warbler	X							
Yellow-Rumped Warbler	X							
Black-Throated Gray Warbler	X							
Townsend's Warbler	X							
Hermit Warbler	X							
MacGillivray's Warbler	X							
Common Yellowthroat	X							
Wilson's Warbler	X							
Yellow-Breasted Chat	X							
Summer Tanager	X							
Western Tanager	X							
Black-Headed Grosbeak	X							
Blue Grosbeak	X							
Lazuli Bunting	X							
Green-Tailed Towhee	X							
Rufous-Sided Towhee	X							
Rufous-Crowned Sparrow	X							

TABLE THREE

	FOOD PREFERENCE				FOOD PREFERENCE			
BIRD SPECIES	Insects	Birds	Rodents	Rabbits	Amphibn	Reptile	Fish	Carrion
Chipping Sparrow	X							
Brewer's Sparrow	X							X
Black-Chinned Sparrow	X							
Vesper Sparrow	X							
Lark Sparrow	X							
Black-Throated Sparrow	X							
Sage Sparrow	X							
Savannah Sparrow	X							
Grasshoper Sparrow	X							
Lincoln's Sparrow	X							
White-Crowned Sparrow	X							
Dark-Eyed Junco	X							
Red-Winged Blackbird	X							
Western Meadowlark	X							
Yellow-headed Blackbird	X							
Brewer's Blackbird	X							
Brown-Headed Cowbird	X							
Hooded Oriole	X							
Northern Oriole	X							
Scott's Oriole	X							
Cassin's Finch	X							
Pine Siskin	X							
Lesser Goldfinch	X							
Lawrence's Goldfinch	X							
American Goldfinch	X							

II. Effects to Forage (continued)

B. Animal Diets (Continued)

2. Vertebrates

a. Terrestrial

Increases in grazing tend to decrease the diversity of small bird, mammal and reptile species (Monson 1941 in Kochert 1989). Small vertebrates that require low levels of cover are favored more than those that need substantial cover. Some herbivorous small mammals utilized by many raptor species may tolerate limited grazing, however few species appear to tolerate intensive long-term overgrazing. Species that may tolerate higher grazing levels are prairie dogs, heteroyid rodents, geomyid rodents and Peromyscus species.

Intensive grazing tends to stimulate annual plant species that provide a good food source for granivorous bird and mammal species (Kochert 1989). In a Black and Frischknecht (1971) study in Utah, deer mice were most abundant in heavily grazed seeded areas and native plant areas with light cover (Ryder 1980). Jackrabbits, cottontails and ground squirrels were found to tolerate moderate levels of grazing (Kochert 1989, Ryder 1980).

Species typical of xeric habitats (heteroyid and geomyid species) maybe favored by grazing whereas species that require denser, perennial forms of vegetation (Microtus species) would not. Stream channelization, a product of long-term overgrazing may result in lowered water tables in riparian areas, followed by replacement of mesophytes by more xerophyllic plants. This conversion could improve habitat for heteromyid rodents but would degrade it for microtines and Sigmodon species.

A switch to a more xeric habitat from overgrazing will change the prey composition and density to a species more readily adapted to those conditions. A change in habitat that promotes Peromyscus species which are nocturnal over those of Microtus species which are diurnal could decrease overall prey vulnerability and availability to diurnal raptors which are adapted to prey on microtus sized rodents, although there maybe no change in overall prey abundance. Kochert raises the question on whether the increase in nocturnal prey will favor owl species (Kochert 1989).

Impacts to raptors as well as other avian groups that prey on adult birds, nestlings, or eggs would be impacted due to changes in prey abundance and diversity. This is based on the impacts described in this document for neotropical birds which constitute a prey base in

part for many raptors. Non-neotropical birds that have similar diet and/or vegetation requirements could be expected to experience habitat alterations as described for migrant species.

Rangeland seeding with native vegetation can benefit habitat for prey, however, planting of certain species such as crested wheatgrass may reduce the density and diversity of raptor prey species. Monocultures of it would affect raptors that fed on lagomorphs, and in Nevada, fewer ferruginous hawk pairs nested near creasted wheatgrass seedlings than in areas of native vegetation (Kochert 1989). However, it was not determined if this was the result of changes in prey abundance for the hawks.

Cattle influences on willows can have beneficial effects on some wildlife. Krueger and Anderson (1985) suggested that cattle have a positive effect on small mammal and bird communities by creating and maintaining tunnels throughout the willow habitat which provides access to the interior and lower portions of the shrubs, thus increasing structural diversity. The tunnels can also provide cover and protection from aerial predators.

II. Effects to Forage (continued)

B. Animal Diets (Continued)

2. Vertebrates

b. Aquatic

Platts (1991) analysis of grazing in riparian areas indicated that, as a group, fish abundances and biomass decline in the presence of grazing. Intact aquatic ecosystems with abundant streamside vegetation insure healthy fish populations (Kauffman and Kreuger 1984). Reduction in vegetation can lead to increased penetrations of sunlight and an increase in water temperature which could adversely affect fish populations (Behnke and Raleigh 1979, Platts 1981). Loss of vegetative cover over time will also reduce the acquisition of downed woody material into the stream reducing cover and increasing the risk of predation to fish. A reduction in the number of bank undercuts, an increase in channel widths, and a general degradation of fish habitat are all conditions that have been attributed to excess livestock grazing and trampling (Behnke and Zarn 1976, Dahlem 1979, Duff 1979, Gunderson 1968, and Heede 1977).

Skovlin (1984) suggests that sediment delivery to the stream channel may be the most detrimental impact of trampling to fisheries. An increase in stream turbidity caused by stream sedimentation leads to a decrease in photosynthesis, resulting in lowered primary productivity and, ultimately, a deficit of the aquatic insect food supply for native salmonid

species (Armour et al. 1991). Increased sedimentation also leads to the destruction of gravel beds used for spawning by salmonids.

Deep meandering streams generally provide the lower temperatures and stream velocities favored by fish. Straightening of the stream channel can result in higher water velocities, especially at headcuts and cut meanders, and lead to an increase in the peak flow and a lowered summer flow (Kovalchik and Elmore 1992).

The reduction in suitable aquatic habitat for fish species could impact the supply of prey in an area for piscivorous bird species such as the belted kingfisher and osprey. However, habitat alterations that removes security cover may expose fish to increased risk of predation. This may enhance the foraging success for the belted kingfisher which may fish along streams.

TABLE FOUR

BIRD SPECIES	FORAGING STYLE				FORAGING STYLE			
	Ground	Foliage	Bark	Hover	Hawk	Pounce	Aerial	Swoop
Turkey Vulture							X	
Osprey							X	
Northern Harrier							X	
Sharp-Shinned Hawk							X	
Cooper's Hawk							X	
Northern Goshawk							X	
Red-Shouldered Hawk							X	
Swainson's Hawk							X	
Red-Tailed Hawk							X	
Ferruginous Hawk						X		X
Golden Eagle							X	X
American Kestrel					X	X	X	
Merlin					X		X	
Peregrine Falcon							X	
Prairie Falcon							X	
Band-Tailed Pigeon	X	X						
White-Winged Dove	X	X						
Yellow-Billed Cuckoo		X		X	X			
Flammulated Owl			X		X			
Burrowing Owl	X			X				X
Long-Eared Owl							X	
Short-Eared Owl							X	X
Lesser Nighthawk							X	
Common Nighthawk	X						X	
Common Poorwill				X			X	

TABLE FOUR

BIRD SPECIES	FORAGING STYLE				FORAGING STYLE			
	Ground	Foliage	Bark	Hover	Hawk	Pounce	Aerial	Swoop
Whip-Poor-Will							X	
Black Swift							X	
Vaux's Swift							X	
White-Throated Swift							X	
Black-Chinned Hummingbird				X	X			
Anna's Hummingbird				X	X			
Costa's Hummingbird				X				
Calliope Hummingbird				X	X			
Broad-Tailed Hummingbird				X	X			
Rufous Hummingbird				X	X			
Allen's Hummingbird				X	X			
Belted Kingfisher								X
Lewis' Woodpecker	X		X		X			
Red-Naped Sapsucker			X		X			
Red-Breasted Sapsucker			X		X			
Williamson's Sapsucker	X		X					
Olive-Sided Sapsucker					X			
Western Wood Pewee				X	X			
Willow Flycatcher				X	X			
Hammond's Flycatcher					X			
Dusky Flycatcher				X	X			
Gray Flycatcher	X				X			
Western Flycatcher				X	X			
Say's Phoebe				X	X			
Vermillion Flycatcher				X	X			

TABLE FOUR

BIRD SPECIES	FORAGING STYLE				FORAGING STYLE			
	Ground	Foliage	Bark	Hover	Hawk	Pounce	Aerial	Swoop
Ash-Throated Flycatcher	X			X	X			
Brown-Crested Flycatcher	X			X	X			
Cassin's Kingbird				X	X	X		
Western Kingbird				X	X	X		
Eastern Kingbird				X	X			
Purple Martin							X	
Tree Swallow		X					X	
Violet-Green Swallow							X	
Northern Rough-Winged Swallow							X	
Bank Swallow							X	
Cliff Swallow							X	
Barn Swallow							X	
Pinyon Jay	X	X			X			
House Wren	X	X						
Marsh Wren	X	X			X			
Golden-Crowned Kinglet		X		X	X			
Ruby-Crowned Kinglet		X		X	X			
Blue-Gray Gnatcatcher		X		X	X			
Swainson's Thrush		X		X	X			
Hermit Thrush	X	X		X				
American Robin	X	X						
Varied Thrush	X	X						
Sage Thrasher	X							
Bendire's Thrasher	X	X						
Water Pipit	X				X			

TABLE FOUR

BIRD SPECIES	FORAGING STYLE				FORAGING STYLE			
	Ground	Foliage	Bark	Hover	Hawk	Pounce	Aerial	Swoop
Cedar Waxwing		X			X			
Loggerhead Shrike							X	X
Bell's Vireo		X						
Gray Vireo	X	X						
Solitary Vireo		X	X		X			
Warbling Vireo		X		X				
Orange-Crowned Warbler		X						
Nashville Warbler	X	X		X				
Virginia's Warbler	X	X			X			
Yellow Warbler		X	X	X	X			
Yellow-Rumped Warbler		X		X	X			
Black-Throated Gray Warbler		X		X	X			
Townsend's Warbler		X			X			
Hermit Warbler		X		X	X			
MacGillivray's Warbler	X	X	X					
Common Yellowthroat		X	X	X	X			
Wilson's Warbler		X	X	X	X			
Yellow-Breasted Chat		X						
Summer Tanager		X		X	X			
Western Tanager		X			X			
Black-Headed Grosbeak		X						
Blue Grosbeak	X	X						
Lazuli Bunting	X	X						
Green-Tailed Towhee	X							
Rufous-Sided Towhee	X	X						

TABLE FOUR

	FORAGING STYLE				FORAGING STYLE			
BIRD SPECIES	Ground	Foliage	Bark	Hover	Hawk	Pounce	Aerial	Swoop
Rufous-Crowned Sparrow	X	X						
Chipping Sparrow	X	X			X			
Brewer's Sparrow	X							
Black-Chinned Sparrow	X	X						
Vesper Sparrow	X							
Lark Sparrow	X							
Black-Throated Sparrow	X	X			X			
Sage Sparrow	X	X						
Savannah Sparrow	X							
Grasshoper Sparrow	X							
Lincoln's Sparrow	X							
White-Crowned Sparrow	X	X						
Dark-Eyed Junco	X				X			
Red-Winged Blackbird	X	X			X			
Western Meadowlark	X							
Yellow-headed Blackbird	X	X			X			
Brewer's Blackbird	X	X			X			
Brown-Headed Cowbird	X							
Hooded Oriole		X						
Northern Oriole		X			X			
Scott's Oriole		X						
Cassin's Finch	X	X			X	X		
Pine Siskin	X	X						
Lesser Goldfinch		X						

TABLE FOUR

BIRD SPECIES	FORAGING STYLE				FORAGING STYLE			
	Ground	Foliage	Bark	Hover	Hawk	Pounce	Aerial	Swoop
Lawrence's Goldfinch	X	X						
American Goldfinch	X	X						

III. INDIRECT EFFECTS TO AVIFAUNA

A. Range Improvements

Structures used to house or control livestock can provide nesting and perching platforms for birds (Kochert 1989), Martin 1984). Raptors can collide into these structures and there have been recorded incidences of owls being impaled on barbed wire fences. (Kochert 1989). Loggerhead shrikes often utilize barbed wire fences for impaling (Zeiner et al. 1990). Ponds and wells may induce conditions for trees which provide roosting and nesting habitat for long-eared owls or marshes which provide foraging and nesting habitat for northern harriers (Kochert 1989).

Chaining, disking, burning and herbicides are used to remove shrubs and trees from grasslands to stimulate grass production. These areas may or may not be planted with crested wheatgrass. In central Utah, an increase in small rodent populations occurred after chaining and reseeding, however these conversion may be detrimental to raptors such as the Swainson's hawk, Cooper's hawk, red-tailed hawk, ferruginous hawk and long-eared owl that may be utilizing the shrubs or trees for nesting. If burning or chaining is done, small woodlots should be left standing to accommodate tree nesting species (Kochert 1989).

Fire or mowing, however, may be desirable for long-term maintenance of upland nesting habitats in their best ecological condition (Kirsch et al. 1979) as long as nesting habitat is provided for annually.

B. Exotic Species

Seedings of non-native graminoid species should be viewed cautiously, since they are generally detrimental to native avian communities. Both species diversity and relative density for vertebrates in general can be negatively impacted by creasted wheatgrass plantings (Graul 1980). Western meadowlarks and Brewer's sparrows tend to decreaser similar in response to that of western wheatgrass, needle-and-thread and fourwing saltbrush to increased summer grazing by cattle on shortgrass ranges in northcentral Colorado (Ryder 1980).

C. Parasitism

Cowbirds have been able to thrive in forested areas by exploiting localized sources of abundant food. For example, the importance of livestock feedlots and corrals as cowbird

foraging centers has been documented in the Sierra Nevada (Trail and Baptista 1991).

Cowbirds follow cattle to scavenge seeds from heaps of dung (Terbough 1992). The use of horses can also help spread cowbirds by providing them with a food source associated with feedlots (Trail and Baptista 1991). Pack stations and other areas of livestock concentration attract cowbirds at some times. Verner and Ritter (1983) suggest that pack stations have supplemented cowbird food sources and have facilitated their colonization and successful breeding in the Sierra Nevada (Stafford and Valentine 1985).

Radio telemetry studies of cowbirds in the Sierra Nevada have shown that females disperse widely from such feeding areas on a daily basis in search of hosts nests (Trail and Baptista 1991). Radio tagged females will commute up to several kilometers from feeding areas to search for nests to parasitize (Terbough 1992). Cowbirds will attempt to parasitize a variety of birds. However, threats from cowbirds to neotropical migratory birds has been primarily to species that utilize open cup nests such as the flycatchers, warblers, and vireos. Data compiled from the Neotropical Migratory Reference Handbook (1994), on the susceptibility to species from cowbird parasitism is displayed in Table Five. Species that fall under the yes category are common "hosts" for cowbirds whereas species listed as occasional are those that have been recorded as having cowbird eggs in their nests.

TABLE FIVE

	COWBIRD PARASITISM				COWBIRD PARASITISM		
BIRD SPECIES	Yes	Occ.	No	BIRD SPECIES	Yes	Occ.	No
Turkey Vulture			X	Common Nighthawk			X
Osprey			X	Common Poor-Will Whip-Poor-Will			X X
Northern harrier			X	Black Swift			X
Sharp-Shinned Hawk			X	Vaux's Swift			X
Cooper's Hawk			X	White-Throated Swift			X
Northern Goshawk			X	Black-Chinned Hummingbird			X
Red-Shouldered Hawk			X	Anna's Hummingbird			X
Swainson's Hawk			X	Costa's Hummingbird			X
Red-Tailed hawk			X	Calliope Hummingbird			X
Ferruginous Hawk			X	Broad-Tailed Hummingbird			X
Golden Eagle			X	Rufous Hummingbird			X
American Kestrel			X	Allen's Hummingbird			X
Merlin			X	Belted Kingfisher			X
Peregrine Falcon			X	Lewis' Woodpecker			X
Prairie Falcon			X	Red-Naped Sapsucker			X
Band-Tailed Pigeon			X	Red-Breasted Sapsucker			X
White-Winged Dove			X	Williamson's Sapsucker			X
Yellow-Billed Cuckoo			X	Olive-Sided Flycatcher		X	
Flammulated Owl			X	Western Wood-Pewee		X	
Burrowing Owl			X	Willow Flycatcher	X		
Long-Eared Owl			X	Hammond's Flycatcher			X
Short-Eared Owl			X	Dusky Flycatcher		X	
Lesser Nighthawk			X	Gray Flycatcher	X		

TABLE FIVE

BIRD SPECIES	COWBIRD PARASITISM			BIRD SPECIES	COWBIRD PARASITISM		
	Yes	Occ.	No		Yes	Occ.	No
Western Flycatcher		X		Varied Thrush			X
Say's Phoebe		X		Sage Thrasher		X	
Vermillion Flycatcher		X		Bendire's Thrasher		X	
Ash-Throated Flycatcher			X	Water Pipit			X
Brown-Crested Flycatcher			X	Cedar Waxwing		X	
Cassin's Kingbird			X	Loggerhead Shrike			X
Western Kingbird		X		Bell's Vireo	X		
Eastern Kingbird	X			Gray Vireo	X		
Purple Martin			X	Solitary Vireo	X		
Tree Swallow			X	Warbling Vireo	X		
Violet-Green Swallow			X	Orange-Crowned Warbler		X	
Northern Rough-Winged Swallow			X	Nashville Warbler	X		
Bank Swallow		X		Virginia's Warbler		X	
Cliff Swallow		X		Yellow Warbler	X		
Barn Swallow		X		Yellow-Rumped Warbler	X		
Pinyon Jay			X	Black-Throated Gray Warbler		X	
House Wren		X		Townsend's Warbler		X	
Marsh Wren		X		Hermit Warbler	X		
Golden-Crowned Kinglet		X		MacGillivray's Warbler		X	
Ruby-Crowned Kinglet		X		Common Yellowthroat	X		
Blue-Gray Gnatcatcher	X			Wilson's Warbler	X		
Swainson's Thrush		X		Yellow-Breasted Chat	X		
Hermit Thrush		X		Summer Tanager	X		
American Robin		X		Western Tanager		X	

TABLE FIVE

	COWBIRD PARASITISM				COWBIRD PARASITISM		
BIRD SPECIES	Yes	Occ.	No	BIRD SPECIES	Yes	Occ.	No
Black-Headed Grosbeak	X			Scott's Oriole			X
Blue Grosbeak	X			Cassin's Finch			X
Lazuli Bunting		X		Pine Siskin		X	
Green-Tailed Towhee		X		Lesser Goldfinch		X	
Rufous-Sided Towhee	X			Lawrence's Goldfinch		X	
Rufous-Crowned Sparrow		X		American Goldfinch	X		
Chipping Sparrow	X						
Brewer's Sparrow		X					
Black-Chinned Sparrow		X					
Vesper Sparrow	X						
Lark Sparrow	X						
Black-Throated Sparrow		X					
Sage Sparrow		X					
Savannah Sparrow		X					
Grasshopper Sparrow		X					
Lincoln's Sparrow		X					
White-Crowned Sparrow		X					
Dark-Eyed Junco		X					
Red-Winged Blackbird	X						
Western Meadowlark		X					
Yellow-Headed Blackbird		X					
Brewer's Blackbird	X						
Brown-Headed Cowbird			X				
Hooded Oriole		X					
Northern Oriole		X					

Conclusion

Changes in vegetative structure and condition set the stage for the changes in bird presence and abundance (Klebenow and Oakleaf 1980). Because birds are known to be responsive to alterations in structure and floristics of habitats such as riparian areas, it is not surprising that neotropical migrants are affected by livestock-induced changes in these habitat characteristics. Certain foraging and nesting guilds have been impacted more than guild from livestock grazing (Bock et al. 1994).

Species that have been less influenced by grazing include aerial, bark, and canopy insectivores. Ground foragers preferring areas with relatively little cover (American Robin) respond more positively to grazing but these species are generally widespread and occur more commonly in other types of habitats. They also tend to be well distributed in ecosystems altered by humans. The brown-headed cowbird is one species that does well and has increased in numbers due to its affliation with livestock. Species that tend to decrease in grazed habitats generally include species that feed on nectar, insects or seeds in the understory or on the ground (Dopkin 1994, Bock et al. 1994).

Bird densities, diversity and species numbers will undoubtably be negatively affected by these long term changes in habitat structure (Szaro 1980). Species with low tolerance indices are restricted to fewer habitats and/or use their selected habitats more unevenly. Such species would be affected most adversely by loss of their preferred habitats (Stauffer and Best 1980). In the western United States, the negative effects of human impact on neotropical birds are likely to be the most dramatic in riparian woodlands, which support the greatest diversity and abundance of neotropical migrants in the west, both in the breeding season and during migration (Dopkin 1994).

GRAZING SYSTEMS

Rangelands contain two basic types of vegetation communities: upland and riparian (BLM Rangeland Reform 1994). No grazing system has shown to be effective in protecting riparian vegetation (Behnke 1979, Tubbs 1980) and Kindschy (1978) recommended the removal of livestock grazing from riparian communities. Few willows (where there should be many) should dictate conservative use. Use can be greater where willows are abundant or where management objectives do not call for increased numbers of willows (Kovalchik and Elmore 1992). Consideration should be made of the condition of riparian areas when implementing grazing systems, and when practical management of riparian woodlands should be done separately from adjacent uplands. When uplands and riparian zones must be managed together, grazing strategies should be keyed to condition of

riparian vegetation (Bock et. al 1994).

Migratory landbirds inhabiting riparian vegetation in western North America are particularly vulnerable to disturbance. Their habitats are so fragmented and limited in distribution that total populations are much smaller than those of most neotropical migrants associated with woodlands of eastern North America (Bock et al. 1994). Livestock grazing is a widespread impact on riparian ecosystems, and one to which many neotropical migrants have responded negatively. Therefore, livestock management decisions about riparian habitats will significantly affect many neotropical migrants. Conservation of neotropical migratory landbirds in the western United States will depend much on protection and restoration of riparian woodlands (Bock et al. 1994).

Once an area has been selected as stable enough to support grazing than consideration must be made as to the type of grazing system to be used. Platts (1982) suggested five steps to consider prior to addressing the recommendations needed for range improvement in wildlife habitat. The first step is to determine the suitability of grazing each of the habitat types on an allotment as some vegetation types should not be grazed at all, based on current condition. The second step is to determine the class of livestock best suited for the area. The third step is to determine the best grazing strategy, and the fourth is to apply the proper stocking rate for desired grazing intensity. The last and most important step for at least riparian habitat is to ensure that there is control of animal distribution.

Driscoll (1967) mentioned that the 5 most common grazing systems are continuous, rotation or alternate, deferred, deferred-rotation and rest-rotation and addressed each in terms of meeting vegetative characteristics in riparian areas. The majority of work pertaining to grazing systems has been conducted within riparian habitat but the assessments can be used to address issues for other habitat types.

Continuous or Season-Long Grazing

Under this system, cattle are typically released into an allotment in the early spring and removed in the fall (Platts 1984). In the spring, cattle often avoid riparian zones because of cold temperatures, soil wetness, and forage immaturity (Krueger 1983). However, cattle can congregate in the riparian zone during the hot summer months. Over use of riparian forage can occur by mid summer as cattle use changes to willows, eventually reducing or in some cases, eliminating the stand. Sedges can be impacted by season long grazing as little opportunity to replace carbohydrate reserves occurs, and sedges may be replaced by grasses and forbs. Reducing the number of cattle does not insure prevention of adverse impacts as the remaining cattle will still tend to congegrate in the riparian zone (Kovalchik and Elmore 1992).

The advantages to this system is that it requires the least investment for range improvements (Kovalchik and Elmore 1992). However, the system is not compatible with either willow or sedge management (Kovalchik and Elmore 1992). The reasons for this are that there are heavy concentration of animals in the same places which causes vegetation deterioration and erosion. Even if cattle were to be evenly distributed along the allotment, some plants will be more heavily grazed and may eventually be destroyed (Driscoll 1967).

Due to the impacts on vegetation, continuous grazing will cause the greatest impact to wildlife especially in riparian habitat. Driscoll's (1967) review of grazing systems indicated that some other system than season long grazing is needed especially in areas where rangeland vegetation needs rehabilitation.

Rest Rotation

Compared with season-long grazing, rest-rotation grazing had improved vigor of vegetation (Ratliff et al. 1972). Rest rotation grazing is well adapted to mountainous terrain, improving use of upland areas (Holechek et al. 1989). Hayes (1978) speculated that since the probability of bank degradation increases as livestock concentrations intensify along streambanks, especially late in the growing season when the vegetation is eaching maturity, that a rest-rotation livestock system would avoid such concentrations at critical times (Buckhouse 1981).

Degraded riparian habitats require complete rest from livestock grazing to initiate the recovery process. In systems requiring long-term rest, the necessary period will be highly variable depending upon the situation. Management also should consider rehabilitating damaged riparian areas through revegetation with native species (Bock et. al 1994).

Rotation or Alternate Grazing

Rotation or alternate grazing is without specific regard for plant reproduction and is best adapted to ranges in relatively good condition (Driscoll 1967). Ecological succession in most grasslands is slower than the frequency of grazing rotation and often leads to uniform vegetative communities. To enable these grasslands to provide habitat for grazing intolerant neotropical migratory birds, it has been suggested that areas should be permanently or at least excluded for at least 25 years from livestock grazing in order to restore and maintain vegetative characteristics needed by these species (Bock et. al 1994).

Deferred

Deferred is best adapted to range that needs improvement (but is not degraded) as it promotes reproduction, restoration and maintanence of plant vigor (Driscoll 1967). However sites in a degraded condition (without willow or sedges) have not responded to the deferred grazing system and other grazing systems are recommended on these sites (Kovalchik and Elmore 1992).

The deferred grazing system involves delaying grazing in an area until seed maturity of important forage species occurs (Payne and Bryant 1994). With deferred grazing, cattle soon concentrate in the riparian zone as riparian use shifts to browsing. Willow stands can be converted to sedge communities or grasses and forbs (Kauffman et. al 1983). Removing cattle before 45 percent forage use will improve the deferred grazing system for willows but only if willow cover and vigor are currently in good condition.

Deferred-Rotation

Deferred-rotation grazing systems have proven effective from vegetation, soil, and wildlife standpoints in mountainous areas (Holecheck et al. 1987). In a study using a three pasture deferred rotation grazing system, Dillion (1958) saw a uniform harvest of a grassland crop on a range site in Washington. The greater number of livestock on a smaller pasture forced the livestock to graze over the entire pasture. They grazed areas away from water as well as those adjacent to water. There was not the selectivity in grazing that existed when the pasture was grazed season-long (Dillon 1958).

The deferred-rotation system allows one pasture to be rested an entire season while the others support the grazing. Sedge communities may respond favorably to this system, as a vegetative mat is left on streambanks in most years (Elmore 1988; Platts 1986). However the system may not improve sedge or willow production on pastures in poor condition (Smith 1989). Smith (1980) and Kindschy (1989) found that less than half of heavily clipped or browsed willow stems survive into the following year. Of the survivors, regrowth was half the growth of ungrazed stems. Therefore 3 or more years of rest may be necessary for heavily used willows to recover. Adding more rest and removing cattle at 45 percent use of forage in the late season period will better protect willows when using this system (Kovalchik and Elmore 1992).

Timing

Just as the timing of livestock grazing can be manipulated to achieve a desired successional stage for maximizing livestock forage production, timing can be used to reach other successional stages to benefit wildlife and avoid or minimize conflicts with critical periods in the life cycles of the wildlife species. Destruction of bird nests and loss of hiding cover are two examples of such conflicts (Kie and Loft 1990).

The grazing period on wet meadows begins between late June and mid-July in California and may continue until early fall. The objective for using cattle to benefit wildlife in meadow communities involves keeping the cattle from congregating in meadow areas summer-long. By delaying cattle grazing until about mid-summer, cover and forage can increase and be maintained. Grazing can then be used to create disturbance in the herbaceous and shrub vegetation (Kie and Loft 1990).

When riparian systems are grazed, moderate use during late-fall and winter, or short-term use in spring, will be less damaging than continuous or growing-season grazing. Fall-winter grazing should be carefully controlled to ensure the maintenance of residual plant cover.

Regardless of the grazing system selected, timing of cattle on the allotment will play a critical role in the establishment and maintenance of desired vegetative characteristics. Unless grazing systems allow for sufficient forage height growth during the mid to late summer period, they will fail to maintain willow dominated plant associations. Sufficient forage height acts to prevent excess browsing, provides for regrowth of riparian plants after use, and leaves sufficient vegetation for streambank protection (Clary and Webster 1989. Incompatible grazing systems might become moderately compatible with willow management if moderate forage height is retained at the end of summer (Kovalchik and Elmore 1992).

Winter Grazing

Winter grazing is seldom used in mountains because of deep snow. However it is reasonably compatible with riparian habitat needs and has been used successively on lower elevation ranges. Riparian forage is not very palatable in the winter and may not receive much use. If used, forage is consumed during the dormant season and there is no regrowth which results in less sediment trapped during early spring runoff. This potentially negative impact on stream morphology has not been a problem, possibly because soils are frozen and less susceptible to trampling and mass wasting (Kovalchik and Elmore 1992).

Spring (Early-Season) Grazing

In the spring, cattle often avoid riparian zones because of cold temperatures, soil wetness, and forage immaturity (Krueger 1983). Therefore spring grazing encourages cattle to graze uplands where forage maturity and climate are more favorable compared to the riparian zone (Platts 1984). As a result, spring grazed riparian zones have less than half the cattle occupancy compared to full use (Kovalchik and Elmore 1992).

As spring grazing precludes late summer use, willow browsing is light and seedling survival is high. Response of riparian vegetation is good, even on sites in poor condition. Vigorous willow and sedge regrowth provide excellent streambank protection, and soil and water relationships remain favorable to continued willow and sedge production (Kovalchik and Elmore 1992). Spring grazing is a good example of a system that avoids late summer use and is compatible with willow management. Compatible systems should be considered where willows have signficant cover or where managers wish to restore willows (Kovalchik and Elmore 1992).

Late Season Grazing

Late season grazing is not much different than season long or deferred grazing in its effects on willows (Kauffman and Krueger 1984; Platts 1984). Willows stands soon degrade to less desirable riparian plant communities. This can be made more effective for willow stands by removing cattle at 45 percent forage use or delaying grazing until regrowth of upland grasses, at which time cool temperatures in riparian zones disperse cattle to uplands (Kovalchik and Elmore 1992).

The system could be improved by reducing cattle numbers to prevent overuse of riparian forage. The conditions can be improved for sedges if cattle are removed early enough to allow fall regrowth,thus providing streambank protection during spring runoff. In practice, the system is incompatible with willow and sedge management unless large pastures are grazed solely for riparian objectives and become, in essence, a riparian pasture (Kovalchik and Elmore 1992).

Distribution

As Platts (1982) mentioned, management objectives for a grazing system will only be effective if animal distribution is controlled. Different methods or a combination of the following methods generally are used in range management: fencing, salting, water developments and herding.

Desired livestock numbers to benefit wildlife depends upon the distribution of forage resources and movement patterns of the livestock. Patchily-distributed, high-quality habitat such as stringer meadows may be severely impacted by livestock while large, open herbaceous meadows would result in wider distribution of animals and a lesser impact (Kie and Loft 1990).

The goal of grazing to benefit wildlife is to influence vegetation structure, biomass, or species composition. A possible way to sustain wildlife values is to monitor cattle impact

on the shrub community. Cattle prefer to forage in open meadows when herbaceous forage is available, but move into shrub stands, such as willow, when forage availability declines. By monitoring impacts on the shrub community, cattle can be removed when that impact becomes undesirable (Kie and Loft 1990).

Higher concentrations of cattle within allotments and efforts to redistribute grazing by water development, salting and herding resulted in increased use of steeper slopes, higher elevations, and broader distribution among habitats (Yeo et al. 1993).

1. Fencing

Where livestock must have access to riparian zones for water, restricted-access fencing can localize and minimize their impacts on streambanks and riparian vegetation (Bock et. al 1994). Fencing is the easiest way to obtain rapid improvement in riparian conditions by protecting riparian zones from improper cattle use (Platts and Raleigh 1984). Though fences are expensive to build and maintain, corridor fencing will maintain or restore willow plant associations, even those in poor condition (Kovalchik and Elmore 1992, Bryant 1992).

Some rest from cattle grazing may be needed to reestablish healthy stands of shrubs such as willows in degraded riparian areas. Skovlin (1984) recommended a 5 year rest followed by proper livestock management. One way to achieve this goal might be through the use of low-maintenance, inexpensive, temporary fencing materials, such as solar powered electric fences. This could be used for several years during the growing season to allow shrubs to reestablish along degraded streambanks or to set up during high soil moisture conditions to reduce streambank trampling.

Short drift fences may be used to control movements of animals to higher elevations until the range there is ready for use, and at the same time encourage full use of the lower ranges. This practice must be used cautiously since livestock will tend to concentrate near fences if the fences cross natural travel routes. Fences are often used to isolate particular vegetation types such as meadows that remain soft and wet late in the season, or other choice grazing areas until they can be used to the best advantage of the vegetation and the livestock. Maintenance costs are usually reduced by fencing along ridges because of less possible damage by wind-thrown timber or snow (Driscoll 1967).

2. Herding

Adequate salt, water and fences seldom assure uniform grazing without the aid of a rider or herder (Driscoll 1967).

3. Salting

A salting plan should include a few permanent salt grounds, as well as many temporary locations. Too few salt grounds may encourage damaging concentrations of animals whereas several areas encourages uniformity of forage use, which may eventually improve range conditions (Driscoll 1967). Salt licks should be scattered on the ridges away from the water to encourage the cattle to graze larger areas (Campsey 1991).

4. Water Developments

Water can be used effectively to control the distribution of livestock. One can either develop it where needed, or remove the source when the herbage has been sufficiently grazed (Driscoll 1967, Schulz and Leininger 1990). If sufficient water is available, an outflow outlet a little distance from a developed livestock trough will also help meet wildlife needs, however, it is best to fence overflow areas so livestock do not trample the outlets (Sherrets 1989). If open storage tanks are used something will be needed to allow trapped birds to escape the deep water. A floating wildlife platform should be installed in all large open water storage tanks (Sherrets 1989).

By providing additional watering sites, heavy utilization of forage in the riparian areas can be reduced as utilization on uplands is increased (Bock et al. 1994).

Exotic Species

Agencies should develop new technologies to discourage the spread of exotic plant species within native riparian systems (Szaro 1988). To reduce the impacts of cowbird parasitism, developments should be located away from habitats richest in host species (Airola 1986).

Monitoring

Regardless of what type of grazing system is used a monitoring plan needs to be developed to track the allotment to assess whether suitable conditions are being maintained or that recovery objectives are being met. When developing a management plan, consideration of pre-grazing site conditions, existing watershed conditions and potential natural vegetation of the site should play a role in establishing the study design and objectives. Platts (1982) indicated that it was necessary to know the condition of a study area prior to the time it was grazed, in order to assess how far out of range the area has become.

The BLM Rangeland Reform (1994) as well as others (quote) divide the health of watersheds into three general categories as a result of management activities:

1. Properly functioning- When vegetation and ground cover maintain soil conditions that can sustain natural biotic communities.

2. Functioning at Risk- When the capabilities of vegetation and soil are susceptible to losing their ability to sustain natural functioning biotic communities. Human activities, past or present, may increase the risks.

3. Nonfunctioning- When vegetation and ground cover are not maintaining soil conditions that can sustain natural biotic communities. When a stream loses its watershed characteristics, it is said to be nonfunctioning. Nonfunctioning riparian communities cannot provide important watershed values and provide the amount and quality of habitat needed by fish and wildlife. Once riparian areas become nonfunctioning, they usually will not recover without major changes in management, however most riparian areas will respond relatively rapidly to management changes once disturbance factors are controlled (BLM Rangeland Reform 1994).

Knowing the overall condition of the watersheds will enable the prioritization of areas to concentrate monitoring and potential restoration efforts on. Properly functioning areas may provide an area as a "control" to compare monitoring data on in areas that are functioning at risk. Nonfunctioning areas, however, may not be able to recover at all or may take decades to recover and may not be the best areas to concentrate on for recovery of neotropical bird species. This is especially important if funds and time are limited and other areas are available that can provide habitat improvement and species recovery at a faster rate. Knowing the potential natural vegetation on area will also enable you to determine what that site can support and what, if any, recovery objectives are needed in terms of habitat restoration. Once a site's characteristics are known, management objectives can be established for wildlife, through the use of management indicator species.

Indicator Species

A grazing program can be designed to maintain or enhance habitat values for a particular wildlife species or group of species, but invariably, some other species will be negatively affected. A thorough understanding of wildlife species' habitat needs and limiting factors is important for developing an appropriate grazing program (Kie and Loft 1990).

Ryder (1986 in Cooperrider etal. 1986) assessed the difficulty of using birds as indicators of habitat quality and habitat changes due to songbirds being highly mobile; resident in certain areas (ie. breeding grounds) for only 3-4 months; and factors affecting them on

wintering grounds where they spend the majority of their annual life cycle. He also went on to say that if birds are inventoried, as managers, skill, time and dedication will be limiting factors. Indentifying many species by sight or sound as well as determination of sex and age classes further compounds the issue from the lack of skilled birds or the time and training needed to acquire those skills.

Either single species or species guild can be used as indicator species. There are consequences and benefits to utilizing both strategies and land managers need to assess which would work best under their particular situation.

Because of differential responses by neotropical migrants to grazing, management programs for single species would be difficult to develop and generally cost prohibitive (Saab et al. 1995). Management of a single species would become necessary only when they become species of special concern and only for the time it takes for species recovery (Saab et al. 1995). An alternative to single species management would be to manage for ecological guilds. However, as conservationists, we need to appreciate the fact that species are largely independent and unique in their needs and we should begin to incorporate that fact into our conservation programs (Hutto 1989).

Regardless of what species are selected, there is common agreement that long range studies with comparible values are needed, especially in areas such as coniferous forests where limited data exists on livestock grazing and birds. Data on long-term reproductive success, in a variety of vegetative cover types, over a broad scale would be a better index of the health of bird populations than abundance data in the short term (Saab et al. 1995). Species habitat requirements may be different from those predicted by information gathered from a limited area and time of the year, where only part of a species' life history requirements are met (Saab et al. 1995).

The ideal study would include large replicated areas totally protected from grazing for long periods. There is a need to asses the influence of livestock grazing in areas that are used for migration and overwintering, not merely important for breeding habitats. This is particularly important in riparian habitats because they are critical for bird migration corridors (Stevens et al. 1977, Szaro 1980, Saab et. al 1995).

Szaro and Balda (1982 in Cooperrider et. al 1986) addressed the difficulty of conducting monitoring efforts and suggested recommendations for selecting bird species as indicator species. This review took the recommendations into consideration and adjusted them to meet the needs of addressing neotropical migrant birds and range management.

Selection Process for Indicator Species

The following criteria were choosen to assist in the selection of indicator species, while considering other limiting factors as mentioned by Ryder (1986).

1. Residency Status

Status enables the managers to assess if the species occurs on their land, at what season does it occur (ie. breeding, wintering) and what other national forests it may be occurring on at the same time in terms of conducting extensive geographical (range) studies. This information can be obtained by using the Neotropical Migratory Bird Reference Handbook (1994). The Reference Handbook contains a Table titled Neotropical Migrant Bird Species: Seasons in Location-National Forests. The Table lists yearlong, summer and winter status for neotropical migrant landbirds. The use of existing compilations of information are stressed here to avoid duplication of work and to save time and money that would be better spent on the actual field monitoring.

Once it is established which species occur in the area and for how long, these remaining species can undergo a process of elimination for the final selection process. This will occur as the other criteria are addressed, or for other reasons that can be supported by biological concerns pertaining to individual species. An example would be the difficulty in monitoring raptors. The Bock et al. (1994) analysis of typical monitoring studies used for livestock grazing indicated that hawks and owls have such large home ranges that their densities cannot be meaningful compared to study plots typically used in these types of studies.

2. Sensitivity to Land Management Activities

In this situation, habitat alterations as a result of range management would be addressed and would depend on the residency status. Some species may not be affected by grazing on their wintering grounds but maybe on their breeding grounds or in their migration corridors. Cumulative effects must also be considered when monitoring species. A combination of species and vegetative community monitoring will help in determining whether population declines are caused by local disturbances. If monitoring indicates no changes in vegetation yet populations are declining, that would indicate that local habitat conditions are not responsible for those declines. Impacts on wintering grounds (Saab et al. 1995) or cowbird parasitism within the breeding grounds may be the cause. These factors may lead to erroneous conclusions in the study area, if not considered. Information for this criteria (range management sensitivity) can be found within the tables and text in this literature review to assess which factor(s) will most likely impact migratory birds (ie. nesting/foraging substrates, cowbirds).

3. Nesting Substrate

Negative impacts to nesting substrate will affect the composition of breeding birds that will occur in a study area. Species most suceptible to loss of nesting substrate from livestock grazing should be considered when selecting indicator species to assess the effects on nesting habitat.

4. Foraging Substrate

Migrants do not mirror one anothers needs because they are not affected identically from changes in foraging substrate. Different species may rely on different items for thier diets (Hutto, 1989). Consideration of foraging substrates, as well as nesting substrate, in terms of livestock grazing impacts needs to be considered both short and long term. Short term effects will be noticed in species utilizing the herbaceous layer whereas those requiring the shrub layer or tree canopy may not be affected until seedling germination and plant succession is altered. Information pertaining to foraging styles can be obtained from Table Four.

5. Status

Indicator species should not be selected merely for their Forest Service or U.S. Fish and Wildlife Status. The majority of neotropical migratory birds have not been considered either as federall listed or Regional Forester designated sensitive species. Status should be based on scientific data indicating changes in population trends and/or habitat loss. All the neotropical migrants have had their status determined and the information can be located in the Neotropical Migratory Reference Handbook (1994) as well as newer information as it becomes available. This information was also used for determining status of the species used in the indicator examples described later in this paper.

6. Ease of monitoring

The lack of skill in identifying bird species is a limiting factor in conducting studies using birds as indicator species. The majority of wildlife biologists or other land managers do not have the skills required by standardized monitoring protocols to identify birds either by sight or sound. Criteria to be considered when selecting species to be monitored by land managers are:

a. Relatively easy to recognize by sight or sound in the field
b. Diurnal
c. If needed, sex and age classes can be distinguished in the field.
d. Can be surveyed utilizing standardized protocols or are already part of

existing transects.

7. The condition or range of conditions species will indicate

This will be set forth in the objectives of the monitoring plan. If the shrub layer is critical for an area and the herbaceous layer will be managed to protect the shrubs, an indicator of both the herbaceous layer and shrub layer will indicate if overuse is occurring especially in terms of nesting substrate. The indicator species will be able to indicate the range of health for vegetative characteristics that are chosen as well as other species of birds if a guild approach is used.

Each forest should take into consideration their individual site conditions and potential avifauna, prior to selecting indicator species. Following are generic examples of how selection criteria can be utilized for selecting indicator species.

Grassland Indicator(s) Example

Western Meadowlark:

1. Residency Status- Found year round on all 18 forests
2. Nest Layer- Herbaceous
3. Foraging Substrate- Ground (Insect)
4. Management Status- Species of Special Interest
   USDA FS RNA "Yellow Book" (Thomas 1979)
   Declining 50% 1966-1989, 69% 1980-1989 in California
5. Sensitivity to grazing- Negative response to vegetation removal
6. Ease of monitoring- Easily monitored with Breeding Bird Surveys (BBS)
7. The condition or range of conditions species will indicate:
   A. Loss of herbaceous layer for nesting
      1. Other species that utilize the same nesting substrate:
         a. **Grasshopper Sparrow**
         b. **Vesper Sparrow**
         c. **Savannah Sparrow**

Riparian Indicator(s) Example

Wilson's Warbler:

1. Residency Status- Found in 16 forests in summer, 1 year round, 1 winter
2. Nesting Substrate- Herbaceous

3. Foraging Substrate- Foliage (Insect)
4. Management Status- No special management status
   Stable except some routes 60% decrease versus 40%, CA in 1980-1989.
5. Sensitivity to grazing- Negative response to shrub and willow removal
6. Ease of monitoring- Easily monitored by BBS routes
7. The condition or range of conditions species will indicate
   A. Loss of herbaceous layer for nesting
      1. Other species that utilize the same nesting substrate:
         a. **Vesper Sparrow**
         b. **Lincoln's Sparrow**
         c. **Virginia's Warbler**
         d. **Savannah Sparrow**
         e. **Orange-Crowned Warbler**
   B. Loss of lower shrub layer for concealment of ground nest
      1. Other species that utilize the same nesting substrate:
         a. **Vesper Sparrow**
         b. **Lincoln's Sparrow**
         c. **Virginia's Warbler**
   C. Loss of riparian vegetation, decrease in prey for foliage insect gleaners
      1. Other species that utilize the same foraging substrate:
         a. **Virginia's Warbler**

Coniferous Forest Indicator(s) Example

Nashville Warbler:

1. Residency Status- Found on 17 forests in the summer
2. Nesting Substrate- Herbaceous
3. Foraging Substrate- Foliage (Insect) and Ground (Insect)
4. Management Status- No special management status
   Stable except some routes 60% decrease versus 40%, CA 1980-1989.
5. Sensitivity to grazing- Negative response to removal of shrub understory
6. Ease of monitoring- Easily monitored by BBS routes with male's song
7. The condition or range of conditions species will indicate
   A. Loss of herbaceous layer for nesting
      1. 1. Other species that utilize the same nesting substrate:

      a. **Dark-Eyed Junco**
      b. **Orange-Crowned Warbler**
  2. Loss of lower shrub layer for concealment of ground nest
    A. Other species that utilize the same nesting substrate:
      1. **Orange-Crowned Warbler**

Oak Woodland Indicator(s) Example

Nashville Warbler:

1. Residency Status- Found on 17 forests in the summer
2. Nesting Substrate- Herbaceous
3. Foraging Substrate- Foliage (Insect) and Ground (Insect)
4. Management Status- No special management status
Stable except some routes 60% decrease versus 40%, CA
1980-1989. 5. Sensitivity to grazing- Negative response to removal of shrub understory
6. Ease of monitoring- Easily monitored by BBS routes with male's song
7. The condition or range of conditions species will indicate
  A. Loss of herbaceous layer for nesting
    1. Other species that utilize the same nesting substrate:
      a. **Dark-Eyed Junco**
      b. **Orange-Crowned Warbler**
2. Loss of lower shrub layer for concealment of ground nest
  A. Other species that utilize the same nesting substrate:
    1. **Orange-Crowned Warbler**

Conclusion

Given the prevalence of livestock in much of the American west, plants and animals intolerant of activities by livestock grazing have relatively few places left to inhabit. This is undoubtedly true for birds and their habitats, which evolved in the absence of livestock. Protection and restoration of ungrazed habitats resembling their prehistoric counterparts must be fundamental to any conservation plan for neotropical migrants and all other plant and animal species in North America (Saab et al. 1995).

Resolution of grazing conflicts does not necessarily mean total elimination of grazing, but rather managing livestock in conformance with other recognized uses of riparian areas (Armour et al. 1991). The National Forest System lands encompass a large proportion of these habitats, thus virtually every management activity has the potential to affect

neotropical migratory bird populations. Loss or degradation of these habitats can reduce neotropical migratory bird populations reproductive success, and migratory and over winter survival rates to the point where population numbers dwindle. In addition many neotropical birds have specialized habitat requirements which are tied to specific components within a habitat type and/or to minimum habitat areas.

Due to their sensitivity to environmental changes, neotropical birds function as "early-warning" system for ecosystem structure and function. By closely monitoring neotropical bird habitat associations and population trends within California habitats, we can track the integrity and resilience of California ecosystems. We can also draw conclusions about ecosystem response to management activities by monitoring the effects of those activities on neotropical populations. An observed decline in neotropical bird populations may herald an imminent decline in other species which depend upon similar habitat and landscape features, and will alert us to the need to take action (Shapley Evans in NTMB Reference Handbook 1994).

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